

The Conference

Origin and Objectives

1. The conference was convened by the United Kingdom Government in the belief that many authorities were becoming increasingly concerned about disturbance from aircraft noise in the vicinity of airports. Invitations were accordingly sent to all States and international organisations likely to be concerned with this problem; the response showed that the problem was indeed world wide and that international discussion in which representatives of Government participated was both timely and welcome.

2. The conference was not intended to reach binding international agreements. Its first objective was to provide a forum for a full exchange of knowledge, experience and ideas. The letters of invitation, however, made it clear that, in the view of the United Kingdom authorities, an essential part of the solution of the problem of disturbance from aircraft noise must be the production, and adoption for general use, of quieter aircraft; and that all other means of alleviating disturbance should be fully and urgently reviewed. In addition it was hoped that the conference might show that, in certain fields, there was scope for the alignment of national policies; and that it might pave the way for further consultation and decisions, at a later stage, through already established machinery for international action. These views were generally accepted by all those attending the conference.

3. The letters of invitation suggested that in certain cases it might be desirable for delegations to include not only Government officials but also representatives of airport authorities, airline operators, aircraft and engine manufacturers and scientists. A number of Governments adopted this suggestion.

4. The International Civil Aviation Organization was consulted about the conference and the President of the Council indicated his full support and willingness to attend. The International Air Transport Association, the Western European Airports Association and other international organisations also accepted invitations to attend.

Conduct

5. Representatives of twenty-six countries and eleven international organisations attended the conference. About 280 persons were present at different times during the proceedings; over 220 of this number played an active and continuous part in the committee work of the conference. A list of heads of delegations is given on page (v). A full list of delegates and observers (other than those who attended the opening and closing plenary sessions by special invitation) is in Appendix A of this report.

6. A meeting of heads of delegations, under United Kingdom chairmanship, was held at Lancaster House on Monday 21st November to discuss conference procedure, including the appointment of chairmen of committees. A second similar meeting was held on Monday 28th November to deal with further procedural matters including the preparation of this report.

7. The conference opened with a plenary session on the morning of Tuesday 22nd November, and closed with a plenary session on the afternoon of Wednesday 30th November. The chairman at both sessions was Mr. Roy Mason, MP, Minister of State, Board of Trade, United Kingdom. Records of the two plenary sessions are in Appendix B.

8. Because of the complexity of the problems confronting it, the conference divided into six committees, which met separately during the period between the plenary sessions, maintaining liaison as necessary. The titles of the six committees and the names of committee chairmen are given on page viii.

9. The reports of the six committees were circulated to all delegates and observers and presented at the closing plenary session by the committee chairmen. The reports of the six committees are in Appendix C.

10. Countries and international organisations were invited to present papers for consideration in committee. Seventy such papers, totalling over 1,340 pages, were received and circulated to all delegates. A list of those papers which can be made available is contained in Appendix D.

11. The official language of the conference was English but, where possible, papers presented for consideration and other documents issued in connection with the conference, were translated into French.

12. Simultaneous interpretation facilities in four languages (English, French, German and Russian), were provided at the conference.

13. With the co-operation of the authorities concerned delegates were able to visit, according to their choice, the two London airports at Heathrow and Gatwick, the Building Research Station at Garston, Watford, some sound-insulated buildings, and the National Gas Turbine Establishment at Pyestock to see equipment and installations having a direct bearing on the subject of the conference.

The Main Themes of Discussion

14. As indicated above, the detailed work of the conference was conducted in six committees, each concerned with separate aspects of the aircraft noise problem. Four main themes emerged, namely :

- (a) The need, in connection with the production of quieter aircraft, to include noise characteristics associated with specified procedures in the criteria for aircraft certification (referred to subsequently for reasons of brevity as 'noise certification');
- (b) The importance of establishing satisfactory methods of specifying noise levels for the purpose of, among other things, setting criteria for the certification of aircraft;
- (c) The desirability of ensuring that land in the vicinity of airports be used as far as possible for purposes which are not incompatible with the degree of noise disturbance likely to be experienced;
- (d) The fact that the continuing contribution to noise abatement made by aircraft operating procedures might be made more effective and in some cases extended, provided that changes in aircraft characteristics and equipment could be made to allow this without degradation of safety and with due regard to economy.

Noise certification

15. It was widely acknowledged that a most important contribution to the reduction of disturbance from aircraft noise would be the introduction of quieter aircraft. A good deal of the discussion in Committee No. 1 resolved into two main questions:

(a) Can worthwhile reductions in noise be achieved by engine and aircraft design and what are the associated penalties?

(b) If such possibilities exist, then how can it be ensured that quieter aircraft will in fact be built and operated in spite of the penalties?

16. Committee No. 1 concluded in answer to the first question that there were a number of techniques under investigation and development which held out prospects of noise reduction in the future. With the advent of engines of high by-pass ratio the main source of noise now lies in the fan rather than in the propulsive jet and a number of measures (see Committee No. 1 report, paragraph 3) are being considered for reduction of noise from this source. The scope for noise reduction by improvement of aircraft design is more limited, but it seems possible that developments could lead to reductions in noise, mainly by improving the operating characteristics of the aircraft whereby they could, for example, be designed to achieve with safety an improved approach procedure at lower levels of thrust.

17. Committee No. 1 pointed out, however, that the design changes aimed at noise reduction were likely to involve penalties in direct operating cost. While the magnitude of these could not at present be assessed with certainty some of the papers indicated that some improvement should be possible without excessive penalties, although it was recognised that there was probably little that could be done to improve the noise performance of existing aircraft without the economic penalties becoming very heavy.

18. With regard to the second question, it became clear that no one airline would be able to operate quieter, but less economic aircraft unless its competitors had to do the same. It was for this reason that committee no. 1 concluded that a mandatory system of certification in respect of noise performance of future new designs of aircraft represented the most practical first step towards ensuring that quieter aircraft would in fact be built and operated.

19. Other committees also emphasised the importance of the introduction of a system of noise certification. Committee No. 2 pointed out that in connection with the planning of land use near airports noise certification was most desirable since it 'should ultimately make more reliable the prediction of the noise disturbance characteristics of future aircraft'. Committee No. 4 was unanimous in its view that if hopes of noise reduction were to be fulfilled 'it was of the utmost importance to introduce as soon as possible a system of noise certification of aircraft including the specification of appropriate operating procedures'. It was also considered that the science of acoustics was sufficiently advanced to enable solutions to be found to the problems of measurement and assessment associated with noise certification. Committee No. 6 noted that, in addition to leading to a reduction in the disturbance caused by aircraft in flight, noise certification could contribute to the reduction of noise from aircraft engines when operated for maintenance or testing on the ground. The aim should be to achieve the maximum international agreement on the standards for noise certification thus minimising, and conceivably in the long term eliminating, local operating restrictions on aircraft so certificated.

20. Thus, from all the discussions at the conference it became abundantly clear—and this was emphasised by speakers at the closing plenary session—

that there was an urgent need for the introduction of a system of noise certification as the most practical method of ensuring that future aircraft would be substantially quieter than those now in operation. Since the initiative in this matter would have to lie with the aircraft manufacturing countries the conference welcomed the action which the United States authorities were taking in seeking powers to introduce such a system in their country, the statement made by Mr. Roy Mason, that the UK intended 'to pursue this matter—in consultation with the governments of other aircraft manufacturing countries—as urgently and as vigorously as we can', and the support given to the proposal by the leader of the French delegation. The conference was also pleased to note the personal interest expressed by the President of the Council of the International Civil Aviation Organization, since ICAO would clearly have an important role to play in the adoption of an international noise certification scheme.

Specification of noise levels

21. Committee No. 4 was able to report progress by the International Organization for Standardization (ISO) and, in particular, the publication on 15th November 1966 of ISO Recommendation 507, *Procedure for describing aircraft noise around an airport*. This specified that the results be computed as Perceived Noise Level in decibels (PNdB) and gave a definitive method of calculation from octave-band analysis of the noise. Committee No. 4 hoped that ISO would consider and proceed to specify the modifications which will be needed to take account of such factors as pronounced pure tone components.

22. It should be noted that the committee reached two significant conclusions :

- (a) that, for aircraft noise, the Perceived Noise Level is the best available predictor of the subjective attribute of noisiness ; and
- (b) that the Perceived Noise Level, modified to take account of such factors as pure tone and duration, should be used in establishing noise criteria for the certification of new aircraft.

23. The committee considered means of assessing total noise exposure—a concept which takes account of the noise of individual operations and of their number and duration over a given period of time. The committee noted that five methods had been put forward in different countries and that a compromise proposal had been formulated by ISO for an amendment to clause 5.5 in ISO/R507, and is at present under consideration by its member bodies. It was considered, however, that the need for full agreement between particular methods of assessing noise exposure was a matter of less urgency, although it should be progressed as fast as possible ; the outcome of the ISO proposal might well be awaited and it might be that further testing against the results of new social surveys was desirable to ensure that a basis for assessing the full social impact of noise exposure is agreed internationally.

Control of land use in the vicinity of airports

24. It was generally agreed that the control of land use near airports was essential to ensure that such use was compatible with the degree of disturbance likely to be experienced in the areas concerned. Planning of this

nature would bring its greatest reward in the siting and development of new major international airports and there should be some scope for, at least, containing the noise problem at other existing airports where the problem of disturbance from aircraft noise had not yet become serious.

25. The powers of national and local administrations to take effective planning action, however, varied in accordance with the legislation in force in the countries concerned. In some cases full planning control could only be exercised at the cost of very large compensation payments though the outlay might be offset in part by revenue from a different use of land. The first requirement for effective land use planning was to identify the areas which would be subject to noise disturbance and the degree of disturbance to which such areas would be exposed. Committee No. 2, which considered this question in detail, pointed out that this may involve difficult problems of prediction and of interpretation. Techniques for this work had been developed in a number of countries but were capable of improvement. The matters considered by Committee No. 4 (which included methods of measuring noise exposure) were of the utmost importance to effective land use control.

26. Committee No. 2 also drew attention to the great importance, if effective action on these lines is to be achieved, of the fullest exchange of information about future plans, and co-ordination of action, between those who are concerned with civil aviation planning, and those concerned at all levels with planning the development of the surrounding land, and with implementing such plans.

27. In addition, the committee drew attention to the need for co-ordination of surface transport planning with the planning of new airport sites, as a means of facilitating the separation of airports from the concentrations of population which they are intended to serve.

Aircraft operating procedures

28. The Conference noted that aircraft operating procedures aimed at restricting noise disturbance had made, and would continue to make, a significant contribution to the alleviation of this disturbance. The need to develop new ideas and new techniques in this field was also stressed but it was concluded that little more could be done in many cases, with existing aircraft and equipment, without degradation of safety.

29. Nevertheless, improved operational noise abatement techniques could be introduced if aircraft were designed to permit them to be carried out with safety. Particular design features which could be potentially helpful in this direction were:

- (a) making the aircraft less sensitive to cross-wind, tail-wind and wet or slippery runways while taking-off or landing, to increase the use of preferential runway systems ;
- (b) improving the aircraft's equipment, so that capture of the instrument landing system glide slope from above can be made using the auto-pilot ;
- (c) improving the aircraft and engine characteristics and instrumentation so that improved approach procedures with reduced power could be adopted ;

- (d) greater flexibility in the rate of climb at take-off and the height at which power reduction could safely be made during the first part of the climb out.

30. Committee No. 6 considered the development of techniques by which engine running up periods for maintenance could be reduced.

31. In addition to these four main themes, discussion at the Conference gave prominence to the need to attack the problem of aircraft noise not from one aspect only but simultaneously by every practicable means.

32. While it was conceded that adequate reduction in disturbance might, in certain cases, be secured by one method only (e.g. by land use planning) such cases were likely to be rare. In a number of countries the problem of disturbance from aircraft noise had already reached such proportions at the main international airports that—taking account of the continual growth of air traffic—all practicable methods needed to be employed if substantial progress in noise reduction were to be achieved. In certain particularly difficult cases these means could include—although this would be a matter entirely for the authorities concerned to decide—the sound-insulation of buildings.

33. The need to exploit every way of attacking the problem of aircraft noise is too urgent to await the results of studies to see whether it is possible to establish the right balance between the various means available. Nevertheless there remains a need to persevere with such studies to ensure that, in the long term, optimum solutions of the problem as a whole can be identified.

Summary of Conclusions

34. The main conclusions of the Conference are summarised below:

- (i) It is technically possible for aircraft with worth-while improvements in noise characteristics to be produced in future but this is likely to involve economic penalties which may be substantial. There is an urgent need for a scheme of noise certification in order that the production and general use of such aircraft can be assured. Such a scheme would, it is hoped, minimise, and conceivably in the long term eliminate, local operating restrictions on certificated aircraft.
- (ii) Perceived Noise Level in decibels, modified to take account of such factors as pure tone and duration, should be used for the purposes of noise certification of aircraft.
- (iii) Local authorities should make the fullest practicable use of their powers both existing, and if necessary extended, to plan and control the land used around airports in order to reduce the impact of existing or potential disturbance from aircraft noise.
- (iv) Reduction of noise by operating and other techniques should be continued but because the possibilities of increased reduction with existing aircraft are severely limited, aircraft would need to be specifically designed or modified to allow the extension of the existing techniques.

- (v) The problem of disturbance from noise is already so serious and—because of the continual traffic growth—is rapidly affecting so many new areas that every practicable means of reducing noise must be employed concurrently.

Results

35. The seventy papers presented for consideration at the conference, together with the reports of the six committees, provide a very full and authoritative survey of the knowledge, experience and ideas of those responsible for, or concerned with, the control of disturbance from aircraft noise in most parts of the world where there is substantial movement of jet aircraft. The conference accordingly fulfilled its primary purpose of providing for a full exchange of ideas and pooling of expert knowledge. The value of this aspect of the conference was clearly indicated by the fact that many delegates considered arrangements should be made for a continuing exchange of information on many aspects of the problems which had been discussed at the conference.

36. It will be seen, however, from the preceding paragraphs that—without attempting to prescribe action either internationally or domestically—the discussions at the conference led to a number of conclusions which, if followed up, could ensure substantial progress in the field of noise control. These include not only the main conclusions summarised in the preceding paragraphs but also a number of suggestions on more detailed points for further action contained in the reports of the six committees.

Suggestions for Further Action

37. This paragraph attempts to summarise the suggestions for future action which might be taken by those responsible for, or concerned with, the control of disturbance from aircraft noise. It will of course be for governments and other authorities concerned to decide what action if any they should take, either domestically or internationally, in respect of the items summarised below:

- (i) Action should be put in hand at once to introduce a system of noise certification of aircraft; the initiative for this will lie with the aircraft manufacturing countries, keeping in close touch with the International Civil Aviation Organization with a view to securing the adoption of an international noise certification scheme.
- (ii) Research on aircraft noise should be urgently pursued and close liaison maintained between the countries concerned with such research.
- (iii) In the field of land use control there should be a full and continuing exchange of information—possibly through the International Civil Aviation Organization—about the action being taken nationally to apply land use controls. Information should also be exchanged about the main characteristics of the relevant national legislation. There should be co-ordination between those concerned with civil aviation planning and those concerned with the planning and

development of the surrounding land. There is a continuing need for more precise methods of assessing total noise exposure.

- (iv) In regard to noise reduction by the use of aircraft operating techniques some detailed proposals for further research and study were suggested in the report submitted by Committee No. 3 (Appendix C). It was also apparent from this Report that when developing future aircraft, attention should be given to making the aircraft less sensitive to cross-wind, tail-wind and wet or slippery runways while taking-off or landing ; improving the equipment so that a capture of the ILS glide slope from above can be made using the auto-pilot ; improving the characteristics and instrumentation so that improved approach procedures with reduced power can be adopted ; introducing greater flexibility in the rate of climb at take-off and in the height at which power reduction can be made during the first part of the climb out. Moreover Committees Nos. 3 and 4 considered it desirable to incorporate in flight manuals information on noise performance for various acceptable procedures.
- (v) Perceived Noise Level in decibels (PNdB) is the best available predictor of the subjective attribute of "noisiness", but the International Organization for Standardization should be asked to proceed to specify modifications which will be needed to take account of such factors as duration and the presence of pronounced pure tone components. So modified, Perceived Noise Level in decibels should be used for the purposes of noise certification of aircraft. Where noise limits at airports are imposed they should be stated in terms of Perceived Noise Level and results of measurements to check compliance should be expressed likewise, even if an approximate method of measurement is used. A number of other detailed suggestions in the field of noise measurement are set out in the report of Committee No. 4 (Appendix C).
- (vi) There is a need for comparable procedures to be used in social surveys carried out by different countries ; account should be taken of the programme for such surveys prepared by the Organisation for Economic Co-operation and Development (OECD). Members of OECD undertaking such surveys should co-operate through that organisation.
- (vii) The insulation of buildings against aircraft noise might be well worth study by those countries whose airports caused serious disturbance to local residents. Further research in the field of sound insulation and the need for internationally acceptable standard methods of measurement on external elements of construction were suggested. Building regulations might lay down standards of noise insulation for external elements of construction.
- (viii) Airport authorities and aircraft operators should be encouraged to pursue all possible measures to reduce the noise made by aircraft running-up engines on the ground, e.g. earth banks, "hush houses", engine mufflers, run-up regulations and improved maintenance techniques. Appropriate land use control will also help to solve this problem.

In Conclusion

38. The Conference has indicated the lines of advance towards, and the action necessary for, the effective control of aircraft noise. It has also demonstrated the co-operative manner in which individual governments and other authorities are prepared to tackle this problem, the general desire for closer international co-operation in the future and the lines on which such co-operation might best be organised. That there is no quick and easy solution will surprise no one. The Conference has established, however, that the substantial reduction of disturbance from aircraft noise without inhibiting the essential development and expansion of civil aviation is a practicable objective. By doing so it has powerfully reinforced the efforts which governments, manufacturers, airline operators and airport authorities will continue to make individually and in co-operation towards the solution of this formidable problem.

APPENDIX A
Delegates and Observers
A. COUNTRIES

		<i>Attending Committee No.</i>
Australia		
Head of delegation	Mr. J. H. Harper First Assistant Director-General (Operations) Department of Civil Aviation	2, 3, 6
Other delegates	Capt. Frank Fischer Flight Manager Training and Development TAA	3
	Mr. Ian Perry Civil Aviation Liaison Officer London	4
	Mr. D. J. Bradford UK Technical Representative Ansett/ANA	6
Austria		
Head of delegation	Dr. Rudolf J. Fischer Director-General Department of Civil Aviation Deputy of the Minister in the European Conference of Ministers of Transport (CEMT)	2
Other delegates	Dr. Karl H. Halbmayer Deputy Director of Civil Aviation	3
	Professor Friedrich Bruckmayer Technical University of Graz Chairman of the Austrian study group for noise abatement (also on <i>International Association Against Noise delegation</i>)	4
Belgium		
Head of delegation	M. R. Lecomte Director-General Régie des Voies Aériennes	2
Other delegates	M. R. Godefroid Assistant Chief Pilot Sabena	3

		<i>Attending Committee No.</i>
Belgium (Contd.)		
Other delegates	M. A. Maenhaut	4
	Technical Service Engineer	
	M. L. Godart	5, 6
	Counsellor	
	Régie des Voies Aériennes	
Brazil		
Head of delegation	Major J. R. Mil Homens Costa Air Ministry of Brazil	
Other delegates	Major H. P. de Macedo	2
	Brazilian Air Force Engineer	
	Capt. W. W. Bräuer	
	Brazilian Air Force Engineer	
	Mr. T. F. Pacheco	5
	Brazilian Air Force Engineer	
Canada		
Head of delegation	Mr. J. R. Baxter Representative in London of the Department of Transport	2
Other delegate	Mr. W. H. Bird Air Canada (Research)	3
Czechoslovakia		
Head of delegation	Mr. Karel Kouba Chief of Airport Construction Division Civil Aviation Administration	2
Other delegates	Mr. Karel Chmielec	1
	Deputy Chief, Research Division Civil Aviation Administration	
	Mr. Novotny	4
	Chief of Civil Aviation Planning Organisation	
Denmark		
Head of delegation	Prof. Fritz Ingerslev Doctor of Technical Science and Professor of Acoustics Copenhagen Technical University (also on ISO delegation)	4

Denmark (Contd.)

Other delegate	Mr. Børge Helmo Larsen Chief of the Technical Division Directorate of Civil Aviation	3, 6
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Finland

Mr. H. Seppälä FINNAIR	2
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France

Head of delegation	M. Jacques Boitreaud Secrétaire Général à l'Aviation Civile	
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Deputy head of delegation (Chairman of Committee No. 4)	M. Pierre Joubert Ingénieur Général des Ponts et Chaussées Président de la Commission du Bruit du SGAC	4
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*Note: M. Joubert became head of the French
delegation after the departure of
M. Boitreaud on Tuesday 22nd November 1966*

Other delegates	M. Paul Besson Ingénieur Civil de l'Aéronautique Directeur Adjoint à la Cie Air-France	1
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M. René Gerard Hoch Ingénieur à la SNECMA	1
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M. Michel Kobrynski Ingénieur Chef du Groupe de Recherches Division Acoustique ONERA	1
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M. Michel Lasserre Ingénieur Principal de l'Air Section Moteurs au Service Technique de l'Aéronautique	1
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M. Bernard Latreille Ingénieur en Chef de l'Air Chef du Bureau Matériel volant à la Direction des Transports Aériens du SGAC	1
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France (*Contd.*)

Other delegates	M. Pierre Lienard Docteur des Sciences Chef de la Division Acoustique à l'ONERA	1, 4
	M. Gerhard Richter Dr. Ingénieur SNECMA	1
	M. Vital Ferry Ingénieur des Travaux de la Navigation Aérienne Service Technique de la Navigation Aérienne	1, 4
	M. Henri Brunard Chef du Service Technique Opérations à l'Aéroport de Paris	1
	M. Jean Wagner Ingénieur Chef du Service—bureau d'études Sud-Aviation (Toulouse)	1
	M. Jean-Pierre Hagoulon Ingénieur Principal Air France	1
	Mlle. Françoise Dissard Docteur en Droit, Diplômée de l'Ecole des Sciences Politiques Urbaniste en Chef de l'Etat	2
	M. Marcel l'Emailet Chef de Service Aéroport de Paris	2, 5, 6
	M. Jacques Lorain-Broca Ingénieur en Chef des Ponts et Chaussées Adjoint au Directeur des Bases Aériennes SGAC	2, 6
	M. Clément Meunier Ingénieur en Chef de la Navigation Aérienne Service Technique de la Navigation Aérienne SGAC	3
	M. Georges Serra Ingénieur Civil de l'Aéronautique Direction des Opérations à la Cie Air-France	3

France (Contd.)

Other delegates	Dr. Paul Grognot Docteur en Médecine Membre de la Commission de Bruit du SGAC Président de la Commission Technique du Bruit au Ministère des Affaires Sociales	4
	M. Edouard Becker Ingénieur en Chef des Ponts et Chaussées Aéroport de Paris	4
	M. Jean-Luc Gérard Lesage Ingénieur de la Navigation Aérienne Adjoint au Chef de Bureau Chargé de l'Exploitation Technique des Aéroports à la Direction de la Navigation Aérienne SGAC	4
	M. Robert Josse Ingénieur d'Ecole Polytechnique Chef de la Division acoustique au Centre Scientifique et Technique du Bâtiment	5
	M. Pierre Bes Ingénieur en Chef de la Navigation Aérienne Chef du Bureau opérations à la Direction des Transports Aériens	6

Federal Republic of Germany

Head of delegation	Dr. F. U. Schmidt-Ott Deputy Director-General of Civil Aviation (1st week)	2
	Regierungsdirektor Dr. G. Lepke Federal Ministry of Transport (2nd week)	2, 6
Other delegates	Oberregierungsrat K. W. Mack Federal Ministry of Defence	1
	Regierungsdirektor Dr. G. Feldhaus Federal Ministry of Health	2
	Dr. Ing. B. Rietdorf Federal Ministry of Transport	2
	Regierungsbaurat M. Heinlein H/Q ATC Services	3

Federal Republic of Germany (Contd.)

Other delegates	Dipl. Ing. W. Jürzig Deutsche Lufthansa	3
	Prof. Dr. H. Bürck Federal Ministry of Defence	4
	Dipl. Ing. A. Reichenbächer Deutsche Lufthansa	4
	Regierungsdirektor Dr. W. Willms Federal Ministry of Health	4, 5
	Dipl. Physician T. Meyer Land Government of North Rhine Westphalia	4, 6 (briefly)
	Dipl. Ing. F. Wagner Land Government of North Rhine Westphalia	6

Greece

Head of delegation	Nicholas Papaioanou Director of Airport Division Ministry of Communications	2
Other delegates	Chrisostomos Papasoteriou Section Supervisor Athens Airport Control	2
	Eleftherios Dourvaris In charge of Athens Airport Control Tower Ministry of Communications Civil Aviation Division	3
	Georgios Carachristos In charge of Flight Operation Section Ministry of Communications Civil Aviation Division	3
	Constantinos Christopoulos Medical Adviser Ministry of Communications Civil Aviation Division	4, 5

Ireland

Head of delegation	Mr. Thomas L. Hogan Chief Airport Engineer	2
Other delegates	Mr. Robert M. Reidy Aeronautical Officer (Operations)	3
	Mr. Leo Carroll Chief Airport Architect	5

Italy

Sgr. Stefano Mossa 2, 4
Inspector-General
Ministry of Transport and Civil Aviation

Japan

Head of delegation Mr. Hisayoshi Teraï 3
Chief, International Affairs Section
Civil Aviation Bureau
Ministry of Transport

Other delegates Mr. Hiroshi Mori 4
Assistant Chief, Aerodrome Management
Section
Civil Aviation Bureau
Ministry of Transport

Mr. Michio Nishihara 2
Professor
Kobe University
(*attending as observer*)

Mr. Yoshiro Nomura 4
Lecturer
Tokyo Municipal University
(*attending as observer*)

Lebanon

Mr. Zouhair Beydoun 1, 2
Director of Civil Aviation

Netherlands

Head of delegation Mr. C. A. F. Falkenhagen 3
(Chairman of Chief, Aeronautical Inspection Division
Committee No. 3) Department of Civil Aviation

Other delegates Mr. D. A. Cornelissen 1
Aeronautical Engineer
Royal Netherlands Aircraft Factory Fokker
Schiphol Airport

Mr. A. J. Beenhakker 2
State-Service for Physical Planning

Mr. J. G. Mesland 2
Head of Operational Services
Amsterdam Airport

Netherlands (Contd.)

Other delegates	Mr. C. H. Reede Head, Technical Research Bureau Royal Dutch Airlines (KLM) Schiphol Airport	3
	Mr. G. J. van Os Deputy Director Institute of Applied Physics Delft	4

Norway

Head of delegation (Chairman of Committee No. 2)	Mr. Erik Willoch Director-General of Civil Aviation	2
Other delegates	Mr. Bjørn Aakre Counsellor Directorate of Civil Aviation	2, 4
	Mr. Ottar Kollerud Manager of Oslo Airport Fornebu	3, 6

Portugal

Sr. J. J. Augusto Chief of Technical Services Lisbon Airport	2, 6
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Republic of South Africa

Dr. C. G. Van Niekerk, Head of Aeronautics, National Mechanical Engineering Research Institute, Pretoria	4
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Spain

Lt.-Col. G. M. Olmedo	
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Sweden

Head of delegation	Mr. Eskil Hellner Secretary-General Ministry of Communications	2
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		<i>Attending Committee No.</i>
Sweden (Contd.)		
Other delegates	Mr. Frid Wänström SAAB	1
	Mr. Hans Walther SAS	3
	Mr. Hans Fugl-Svendsen SAS	3
	Mr. Jan Wessel Superintending Engineer Board of Civil Aviation	4
	Mr. S. Blomberg Senior scientist	4
Switzerland		
Head of delegation	M. Albert Münch Vice-Director Federal Air Office	1
Other delegates	M. Herbert Weibel Head of Airports Department Federal Air Office	2
	Dr. Ernest Altorfer Director Zürich Airport	2, 6
	M. Charles Bratschi Director Geneva-Cointrin Airport	3
	M. Anselm Lauber Chief of Acoustics Section and Noise Reduction Federal Institute of Research	4
	M. A. Buhler Section Chief Federal Division of Police	4
Thailand		
	Dr. Boonsorn Boonsukha Chief of Construction and Maintenance Division Department of Aviation Ministry of Communications	2

Union of Soviet Socialist Republics

Head of delegation	Mr. A. G. Munin Deputy Head of Section Ministry of Aircraft Industry	1, 6
Other delegates	Mr. V. E. Kvitka State Civil Aviation Institute Moscow	1, 3
	Mr. K. V. Yanvarev Head of Section Ministry for Aircraft Industry	3
	Mrs. N. B. Titova Ministry for Aircraft Industry	6
	Mr. B. Lifanov Embassy of the USSR London	

United Kingdom

Head of delegation	Mr. Frank Wood, Second Secretary Board of Trade Civil Aviation Department	
Other delegates	Mr. P. Lloyd Director-General, Engine Research and Development Ministry of Aviation (<i>Rapporteur Committee No. 1</i>)	1
	Mr. D. E. Morris Director-General, Civil Aircraft General Services Ministry of Aviation <i>or</i> Dr. D. Cameron Director, Civil and Transport Aircraft Research and Development Ministry of Aviation	
	Mr. G. V. Hole Chief Executive British Airports Authority	1

United Kingdom (*Contd.*)

Other delegates	Professor G. M. Lilley Chairman, Noise Research Committee of the Aeronautical Research Council Head of the Department of Aeronautics and Astronautics The University Southampton	1
	Professor E. J. Richards Director, Institute of Sound and Vibration Research The University Southampton	1
	Mr. K. G. Wilkinson Chief Engineer BEA	1
	Mr. W. A. Richardson Chief Engineer British United Airways Ltd.	1
	Mr. F. B. Greatrex Rolls Royce Ltd. (also on ISO delegation)	1, 4
	Mr. R. Bridge Rolls Royce Ltd.	1
	Mr. J. D. Voce Chief Noise Engineer Bristol Siddeley Engines Ltd.	1
	Mr. J. W. H. Thomas Deputy Chief Aerodynamicist Hawker Siddeley Aviation Ltd.	1
	Mr. I. M. Davidson Deputy Director, Research and Development National Gas Turbine Establishment (NGTE)	1, 4
	Mr. P. A. Hufton Deputy Director (A) Royal Aircraft Establishment	1
	Mr. J. F. Holford Royal Aircraft Establishment	1

United Kingdom (Contd.)

Other delegates	Mr. G. H. Capsey Deputy Director of Flight Safety (A) Board of Trade Civil Aviation Department	1
	Mr. D. G. H. Higgins Engine Research and Development Division Ministry of Aviation (<i>Technical secretary for Committee No. 1</i>)	1
	Mr. A. V. Davies Assistant Secretary Aerodromes (General) Division Board of Trade Civil Aviation Department (<i>Rapporteur for Committee No. 2</i>)	2
	Mr. G. W. Pitt Director of Traffic and Public Relations British Airports Authority (<i>also on ICAA Delegation</i>)	2
	Mr. C. W. Baldwin Ministry of Housing and Local Government	2
	Mr. E. G. S. Sibert Deputy County Planning Officer Surrey County Council (representing local authority associations)	2
	Mr. E. Wright Head of AT7 Aerodromes Technical Directorate Board of Trade Civil Aviation Department	2
	Mr. R. F. Fenn Aerodromes (General) Division Board of Trade Civil Aviation Department (<i>Technical secretary for Committee No. 2</i>)	2
	Mr. N. F. Hildyard Deputy Director of Control (Operations) Controllerate of National Air Traffic Control Services (CNATCS) (<i>Rapporteur for Committee No. 3</i>)	3

United Kingdom (Contd.)

Other delegates	Air Commodore R. Berry Director of Control (Operations) CNATCS	
	Mr. C. M. Colbeck Divisional Controller Civil Aviation Divisional Office (Southern Division) Board of Trade Civil Aviation Department	3, 4
	Mr. L. G. M. Rees Civil Aviation Divisional Office (Southern Division)	3
	Sir John Briscoe Director of Operations British Airports Authority	3
	Mr. D. R. Murrin Air Registration Board	3
	Captain D. C. Cole (Flying duties) BOAC	3
	Mr. R. H. Whitby BEA	3
	Captain F. Dell Flight Manager Tridents BEA	3
	Captain P. Hoare British United Airways Ltd	3
	Captain E. E. Rodley British Airline Pilots' Association	3
	Mr. C. K. Cole Airport Commandant The Airport Luton (Joint Airports Committee of Local Authorities)	3
	Mr. C. T. Farnell Chairman of the Technical Committee Guild of Air Pilots and Air Navigators	3

		<i>Attending Committee No.</i>
United Kingdom (Contd.)		
Other delegates	Capt. N. C. Green Guild of Air Pilots and Air Navigators	3
	Mr. A. H. Jessell Deputy Director of Control (Plans)	3
	<i>or</i>	
	Mr. R. Butler (C(P)3) Directorate of Control (Plans) CNATCS	
	Mr. W. C. Woodruff Deputy Director of Civil Air Traffic Operations CNATCS	3
	<i>or</i>	
	Mr. H. E. Wood Head of CATO 1 Directorate of Civil Air Traffic Operations CNATCS	3
	Mr. A. Anscombe ACT 1(a) Civil and Air Transport Aircraft Research and Development Division Ministry of Aviation	3
	Mr. A. P. Brown SF (A) 3 Directorate of Flight Safety Board of Trade Civil Aviation Department	3
	Mr. R. A. W. Cooke-Smith C Ops 8 Directorate of Control (Operations) CNATCS (<i>Technical Secretary for Committee No. 3</i>)	3
	Mr. F. L. Sawyer Head of Aviation Operational Research Branch Board of Trade Civil Aviation Department (<i>Rapporteur for Committee No. 4</i>)	4

		<i>Attending Committee No.</i>
United Kingdom (Contd.)		
Other delegates	Dr. A. E. Knowler Aviation Operational Research Branch Board of Trade Civil Aviation Department	4
	Mr. F. C. Petts Civil Aviation Divisional Office (Southern Division)	4
	Dr. D. W. Robinson National Physical Laboratory	4
	Mr. D. J. N. Wakeling Engineering Superintendent, Special Duties BOAC	4
	Mr. B. Kerry British United Airways (Assistant Chief Designer, Aviation Traders (Engineering) Ltd)	4
	Dr. I. C. Cheeseman Turbo Machinery Department National Gas Turbine Establishment (NGTE)	4
	Mr. R. S. S. Dickinson United Kingdom Representative on the Council of ICAO (also on ICAO delegation)	4
	Mr. T. J. Hargest Turbo Machinery Department National Gas Turbine Establishment (NGTE)	4
	Mr. R. A. Pinker Turbo Machinery Department National Gas Turbine Establishment (NGTE)	4
	Mr. N. Fleming Aviation Operational Research Branch Board of Trade/Civil Aviation Department (Technical secretary for Committee No. 4)	4
	Mr. K. Alsop (Chairman of Committee No. 5) Building Research Station (Rapporteur for Committee No. 5)	5

United Kingdom (Contd.)

Other delegates	Mr. N. J. Payne Director of Engineering British Airports Authority	
	Mr. K. M. McLeod Director of Finance British Airports Authority	
	Mr. P. H. Parkin Building Research Station	5
	Mr. E. F. Stacy Building Research Station (<i>Technical secretary for Committee No. 5</i>)	5
	Mr. G. F. K. Donaldson (<i>Chairman of Committee No. 6</i>) Deputy Director, Aerodromes Technical Directorate Board of Trade Civil Aviation Department (<i>Rapporteur for Committee No. 6</i>)	6
	Mr. R. H. Laver Facilities Superintendent, Engineering and Maintenance BOAC	6
	Mr. R. H. Doggett Assistant Planning Manager, Engineering BEA	6
	Mr. M. W. Hale Chief Projects and Development Engineer British United Airways Ltd	6
	Mr. G. Needham Meteorological Office	6
	Mr. N. W. McCue (RDT 1) Directorate of Aircraft Mechanical Engineering Equipment Research and Development Ministry of Aviation	6
	Mr. A. H. Fernand Aerodromes Technical Directorate Board of Trade Civil Aviation Department (<i>Technical secretary for Committee No. 6</i>)	6

United Kingdom (Contd.)

*The following joined with the United
Kingdom delegation at committee meetings,
or at plenary sessions*

Mr. Gwyn Griffiths Airport Commandant States of Jersey	4
Air Vice-Marshal J. B. Russell Controller of National Air Traffic Control Services (CNATCS)	
Mr. Handel Davies Deputy Controller of Aircraft, Research and Development Ministry of Aviation	
Mr. E. R. Stables Director of Aircraft Mechanical Engineering Equipment Research and Development Ministry of Aviation	
Mr. G. A. Champniss Deputy Director of Operations British Airports Authority	2
Mr. G. J. Wareup Deputy General Manager (Operations) London (Heathrow) Airport British Airports Authority	6
Mr. P. F. Eames Assistant General Manager (Operations) London (Gatwick) Airport British Airports Authority	6
Mr. J. D. Perret Chief Planning Engineer British Airports Authority	
Mr. B. H. Barber Assistant Director of Electronics Research and Development (Civil Aviation) Ministry of Aviation	
<i>or</i>	
Sqn. Ldr. R. W. Kemsley Directorate of Electronics Research and Development (Civil Aviation) Ministry of Aviation	3

United Kingdom (Contd.)

*United Kingdom observers invited to be
present at plenary sessions*

Mr. F. W. Banfield
(Member of Greater London Council)
Vice-Chairman, Airport Consultative
Committee
London (Heathrow) Airport

Mr. D. I. Bosanquet
Airport Consultative Committee
London (Gatwick) Airport

Mr. John Connell
Noise Abatement Society

Sqn. Ldr. A. W. Day
Airport Owners Association

Mr. E. Epsom
British Association for Control of Aircraft
Noise

Mr. S. Eustace
Association for the Reduction of Aircraft
Noise

United States of America

Head of delegation	Mr. Raymond A. Shepanek Director, Noise Abatement Staff Federal Aviation Agency	2
Other delegates	Mr. J. F. Woodall Aircraft Development Service Federal Aviation Agency	1, 4
	Mr. Harvey H. Hubbard (Chairman of Committee No. 1) Chief, Acoustics Branch Langley Research Centre National Aeronautics & Space Administration	1
	Mr. J. M. Tyler Project Engineer Pratt & Whitney Aircraft United Aircraft Corporation	1, 4
	Mr. Sherman S. Edwards Chief Acoustics Engineer (SST) Lockheed Aircraft Corporation	1

		<i>Attending Committee No.</i>
United States of America (Contd.)		
Other delegates	Mr. Walter Swan Staff Engineer The Boeing Company Airplane Division	1
	Mr. John B. Large The Boeing Company	1
	Mr. Schnyler Kleinhans Vice-President, Engineering Douglas Aircraft Company	1
	Mr. Frank E. Lenherr General Manager, Advance Technology and Demonstrator Programmes General Electric Co.	1
	Mr. C. M. Haar Assistant Secretary for Metropolitan Development Department of Housing and Urban Development	2
	Mr. R. F. Bacon Chief, Systems Planning Division Airports Service Federal Aviation Agency	2
	Mr. W. E. Downs Commissioner of Aviation Department of Aviation Chicago	2
	Mr. L. M. Tondel Cleary, Gottlieb, Steen and Hamilton (Air Transport Association of America)	2
	Mr. R. B. Meyersburg Deputy Director, Aircraft Development Service Federal Aviation Agency	3
	Mr. P. Donely Flight Mechanics and Technical Division Langley Research Centre National Aeronautics and Space Administration	3
	Mr. H. F. Clark Airline Pilots' Association of America	3
	Mr. A. V. Appleget Manager, Flight Standards Eastern Airlines Inc. (Air Transport Association of America)	3

United States of America (*Contd.*)

Other delegates	Mr. R. L. Randall Deputy General Counsel Federal Aviation Agency	4
	Dr. S. R. Mohler Chief, Aeromedical Application Division Federal Aviation Agency	4
	Dr. R. K. Cook National Bureau of Standards	4
	Dr. H. Von Gierke Bio-Acoustics Branch, Aerospace Medical Laboratory US Air Force	4, 5
	Mr. F. W. Kolk Assistant Vice-President Engineering R & D American Airlines (Society of Automotive Engineers)	1, 4
	Mr. A. H. Odell Supervisor, Aeronautical Planning The Port of New York Authority	2, 4
	Mr. H. F. Marthinsen Engineering and Air Safety Department Airline Pilots' Association of America	3, 4
	Dr. W. J. Galloway Vice-President, Applied Research Consulting Development Bolt, Beranek and Newman, Inc. (Acoustical Society of America)	4
	Mr. J. E. Stephen General Counsel Air Transport Association of America	4
	Mr. Sidney Goldstein General Counsel The Port of New York Authority	4
	Mr. W. B. Becker Assistant Vice-President, Operations Air Transport Association of America	4
	Mr. J. Donald Reilly Director, Legal Services, Airport Operations Council International	4

United States of America (Contd.)

Other delegates	Mr. F. Crompton Assistant Commissioner for Technical Standards Federal Housing Administration	5
	Dr. L. L. Beranek Chairman, Acoustical Standards Board Bolt, Beranek and Newman, Inc.	4. 5
	Mr. George M. McSherry Assistant General Manager Los Angeles Department of Airports	6
	Mr. R. J. Loew Federal Aviation Agency	

The following also attended the conference as part of the delegation

Mr. John Meadows Civil Air Attaché US Embassy London	
Mr. Clinton Van Cott Assistant Civil Air Attaché US Embassy London	4
Mr. Addison B. Johnson Representative in London Federal Aviation Agency	

B. ORGANISATIONS

Council of Europe

Mr. H. Pfeffermann Head of Public Health Division Secretariat-General Strasbourg France	4
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European Civil Aviation Conference (ECAC)

Mr. R. Burns
Vice-President

International Civil Aviation Organization (ICAO)

Head of delegation	Mr. J. A. Newton Chief, Flight Branch ICAO Secretariat Montreal Canada	3
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International Civil Aviation Organization (ICAO) (Contd.)

Other delegate	Mr. John Lerew Chief of Aerodromes, Air Routes and Ground Aids Section ICAO Secretariat Montreal Canada	4
	Mr. W. Binaghi (President of the Council of ICAO) <i>was present at the closing plenary session. In his unavoidable absence from the opening plenary session a message from Mr. Binaghi was read by Mr. R. S. S. Dickinson</i>	
	Mr. R. S. S. Dickinson (First Vice-President of the Council of ICAO) <i>was present throughout the conference (also on United Kingdom delegation)</i>	

*The following members of the Council of ICAO were also present
during the conference*

Col. A. O. Cruz Philippines	
Mr. P. K. Wambua Kenya	2

International Air Transport Association (IATA)

Head of delegation	Capt. J. E. Frankum Vice-President, Transportation Trans World Airlines Inc. New York	
Other delegates (Representing IATA Secretariat)	Mr. J. L. Gilmore IATA Regional Technical Representative London	
	Mr. L. I. Cook QANTAS	1
	Mr. E. L. Killip BEA	2
	Mr. J. Hardonk	2
	Mr. J. H. Harding PANAM	3

International Air Transport Association (IATA) (Contd.)

Other delegates (Representing IATA Secretariat)	Capt. P. A. Baumann Swissair	3
	Mr. R. H. Chowns BEA	4
	Mr. H. Stien	5
	Mr. E. Vuille Swissair	6

International Civil Airports Association (ICAA)

Mr. G. W. Pitt
British Airports Authority
(also on UK delegation)

International Federation of Air Line Pilots' Associations (IFALPA)

Head of delegation	Capt. F. Bateman KLM Pilots' Association	3
	Mr. C. C. Head IFALPA Deputy Executive Secretary	4

International Organization for Standardization (ISO)

Head of delegation	Mr. A. D. Falk Technical Officer British Standards Institution	2, 3, 4
Other delegates	Mr. F. B. Greatrex Chief Engineer, Staff Engineer Rolls Royce Ltd. (also on UK delegation)	1, 4
	Prof. F. Ingerslev The Acoustics Laboratory Technical University of Denmark (also on Danish delegation)	4
	Mr. I. J. Hirsh Central Institute for the Deaf St. Louis Missouri USA	4

Institute of Transport Aviation (ITA)

Mr. R. J. L. Balat Chief Engineer Institute of Transport Aviation (technical expert)	3, 4
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**Organisation for Economic Co-operation and Development
(OECD)**

Prof. P. Atteslander 4
Berne University

Western European Airports Association (WEAA)

Head of delegation Dr. W. Treibel 1
Director
ADV
Stuttgart

Other delegates M. Lorin 1
Executive Staff
Paris Airport

Mr. M. Lukens 3
Port of New York Authority

M. R. Aucouturier 3
Executive Staff
Paris Airport

Mr. C. D. Waldron
General Manager
London (Heathrow) Airport
British Airports Authority

International Association against Noise

Professor Friedrich Bruckmayer 4
Technical University of Graz
(Chairman of the Austrian Study Group
for Noise Abatement)
(also on Austrian delegation)

Records of the Plenary Sessions

1. The Opening Plenary Session

Tuesday 22nd November 1966, 10.00 hours

The Long Gallery, Lancaster House

*Chairman : Mr. Roy Mason, MP, Minister of State Board of Trade
United Kingdom*

Mr. Roy Mason : On behalf of Her Majesty's Government in the United Kingdom I welcome you all to this conference and also thank you for coming.

This is the first international conference at government level which has been convened to discuss the question of aircraft noise. Twenty-six States and eleven international organisations have sent representatives to the conference and this, I think, confirms the United Kingdom Government's belief—which was the main reason for calling the conference—that disturbance from aircraft noise is now, or is fast becoming, a major problem in many countries, and that many governments are now much concerned with finding the best methods of dealing with it. In addition to the representatives from governments we are very glad to see that all the international organisations invited to the conference have been able to send delegations.

We have, therefore, gathered here a unique body of experience and ability and I hope it will be possible during the next few days to make full use of it in exploring to our mutual advantage all aspects of this complex, intractable but, I repeat, immensely important and urgent subject.

In our plans for this conference we have kept in close touch with the International Civil Aviation Organization and we are particularly glad that the President of the Council will—despite his many other commitments—be present. He is, unfortunately, unable to attend this opening session but he intends to be present at the closing plenary meeting and will then address the conference. Other members of the ICAO Council and Secretariat will, I understand, be present throughout the conference.

I should like to make it clear at the outset that the purpose of the conference is not to discuss whether there is a noise problem, or whether the problem is a serious one. We accept that the problem exists and is very serious and that unless adequate measures are taken the amount of annoyance inflicted by aircraft will considerably increase in the coming years. We shall, therefore, be addressing ourselves immediately to the question of how we can reduce this disturbance and in doing this we shall consider all practicable methods. I am sure that there is no one simple answer that will remove our difficulties. We, in the United Kingdom, share the view that has already been expressed in the United States and elsewhere that all methods of controlling aircraft noise must be investigated, and that only by attacking the problem from all sides are we likely to achieve the substantial improvements we all desire.

This problem of disturbance from aircraft noise and how it has reached its present proportions is largely a product of the jet age. The advent of jet aircraft and the astonishing growth of air traffic have, in one decade, completely altered the character of the problem. Here in London we have to face it in one of its most aggravated forms; we have a very busy airport with a high proportion of jet aircraft very near to built-up areas. Aircraft approaching to land have to make their descent over thickly populated parts of the city. Aircraft on take-off, although confined to routes that have been designed to cause the least disturbance to people on the ground, have, on many occasions, to climb away from the airport over large residential areas. We have, of course, taken a number of measures to minimise the disturbance these aircraft cause and have been the first country in the world to introduce a scheme under which grants are paid towards the cost of insulating homes against noise. But we still have a long way to go before we can begin to say that we are in sight of a practicable solution. I believe that a somewhat similar problem exists with the John F. Kennedy International Airport in New York, though there of course they have an advantage that some of the approach and departure routes can be over the sea.

Of course disturbance would be immediately and substantially reduced if we banned aircraft at certain hours and drastically restricted the number of permitted movements at other times. There are people who are so distressed by the noise of aircraft that they would like this to be done. But proposals on these lines simply disregard the economic penalties involved not simply for the airlines and the airport authorities but for the nations at large. What we must seek are ways of reducing noise which will permit civil aviation to continue its present development and enable it to retain its essential place as a major means of communication, travel, commerce and industry between the nations of the world.

It is clear that reduction in the disturbance from noise cannot be achieved without cost. Already the noise control measures adopted by many governments are involving considerable expenditure, or loss of revenue, quite apart from the money which is spent on research. The airlines themselves too have already spent many millions of pounds on silencing and other noise reduction equipment, accepting this as an inescapable part of modern civil aviation operations. It would be foolish to imagine that further progress in limiting disturbance can be made without increased cost. Equally there are limits to the costs that the civil aviation industry or indeed governments can bear. The economic factor must therefore play an important part in our consideration of further action. It really is a question of balance or compromise, though in fact in saying this I would stress again that no one here should underestimate the importance of the social considerations involved.

One factor of overriding importance, on which there can be no compromise, is that of safety, both of those in the air and, particularly those living near airports, on the ground as well. The high standards of safety of civil aircraft operations must be maintained, and indeed improved wherever possible.

What then is the purpose of the conference? We are all faced, in varying degrees, with the urgent need for reducing disturbance from aircraft noise by every practicable means we can devise. The aim of the conference therefore

is that we should be able to discuss together ways of doing this, to pool our knowledge and experience and ideas. It is not intended that, in the short time available, we should try to reach binding international agreements. That would, in any case, be inappropriate for a conference of this kind as the letter of invitation to this conference has already made clear. But we would certainly hope that the papers which have been prepared for the conference, and the discussions that will take place in its committees, will show us all what are the most promising lines to be pursued and where progress can and must be made.

If I might single out one particular line of advance I should like to refer especially to the need for quieter aircraft. Committee No. 1 will be addressing itself directly to this question. We, in the United Kingdom, have noted with great satisfaction the proposals which the United States Government are considering for including noise as a factor in the certification of aircraft. We hope that discussions in Committee No. 1 will show that technological developments are available—or are likely to become available—which will enable new generations of aircraft to meet the requirements of airline operators without inflicting the present amount of disturbance caused to people on the ground. It is to be hoped therefore that within the near future it will be possible to fix standards of noise performance for future aircraft which will show a considerable improvement compared with the performance of aircraft now operating.

I have mentioned Committee No. 1 in particular but each committee will have a part to play since all methods of noise reduction, whether by the introduction of quieter aircraft, by land use control, by the development of new operating techniques, by more efficient methods of noise assessment, or by any other means, must be brought into effect if we are to make the necessary impact on this problem.

In conclusion, may I repeat that we are not expecting this conference to produce some simple solution that will solve all our difficulties. The problem is too complex for that and it will take an immense amount of work over a considerable period to achieve the improvements we all want. I am confident, however, that the discussions in this conference will stimulate advances on many fronts, and I hope that this conference will be seen as a first attempt to get to grips internationally with what is now becoming an international problem.

Gentlemen, may I wish you all success.

Mr. Mason : I should now like to call upon Mr. Dickinson, who will read a message from Mr. Binaghi, President of the Council of ICAO.

Mr. Dickinson : Mr. Binaghi's message is as follows :

I regret not to be present at the opening of the Conference on the Reduction of Noise and Disturbance caused by Civil Aircraft. The ICAO regional meeting starts today in Mexico City, and I must be there. I expect, however, to attend the last three days of the conference.

I would like to emphasise my appreciation of the fact that the civil aviation authorities of the United Kingdom, before taking a decision to hold this conference, sought our views and reactions to the idea.

This desire to co-ordinate the project with ICAO is another example of the support that the United Kingdom has always given to our Organization.

The initiative taken by the Government of the United Kingdom in convening this conference is especially welcomed by ICAO.

The subject does not lend itself easily to international regulations, which explains why ICAO has not been able so far to do much about it. I am confident, however, that your discussions will contribute greatly to ascertaining those problems requiring solution on an international basis, thus assisting ICAO in establishing a stand for international action. The support of ICAO for this undertaking is signified by the attendance of ICAO representatives and two members of our technical secretariat. I wish the conference every success.

Thank you, Mr. Chairman.

Mr. Mason : Thank you, Mr. Dickinson. A number of delegates have intimated to me that they would like to make a short contribution during the course of this morning's session, and I will call upon M. Boitreaud, head of the delegation of France.

M. Boitreaud : Mr. Chairman, distinguished delegates. My first and introductory words will be those of congratulation to the United Kingdom civil aviation authorities for having taken the initiative in promoting and convening this conference, and an expression of our thanks for the most excellent organisation which has been put at the disposal of the delegations which have accepted this very timely invitation in order to exchange their views and pool their information about the problem of noise and disturbance caused by civil aircraft.

This conference, as I have said, is very timely. We of the French delegation are unanimous in our feeling of goodwill toward the conference, and we hope that all those present will, like us, consider that they must from this point work together to define at least the data of the problems and, of equal importance, to discover, if possible, common ways of solving the common problem. This problem is extremely urgent and, furthermore, it seems to me that, like many others relating to transport on a largely international level (such as air transport), it cannot be resolved satisfactorily except at an international level.

Noise cannot be divorced from the activities of mankind in modern times. There are always with us the machines which play an ever more important part in our lives ; aircraft become ever more noisy as they become faster and more powerful, that is to say, for us, more useful and efficient. This is regrettable but it is inevitable and it is a fact.

Gentlemen, there comes a moment in all sectors of industrial development when we have to put to ourselves the question of the compatibility of technical advance with the need to safeguard human interests, the activities of human life and the conditions of modern living. When the machines, which have become an absolutely integral part of our lives, begin to become intolerable at least to those who are most exposed to the disturbance caused by aircraft, then, as someone has said, it is a question of knowing how far we can go without going too far.

There was a time when the noise from civil aircraft was tolerable for nearly everyone. The design and the power of the engines, the small amount of traffic, the fact that the aerodromes used were fairly well away from densely inhabited areas, all meant that civil aircraft were less of a nuisance to people than the noise from, for example, ordinary motor transport. But times have changed and the noise from turbine and jet has made things intolerable for many people living in the vicinity of airports.

However, it is not only that the intensity of noise from aircraft has changed, but also the fact that the population who live in the immediate proximity of airports has increased. Although we say that habit or familiarity breeds contempt, it is none the less rather difficult to assume that this could apply to people living near airports and suffering from the annoyance of aircraft noise. We must tackle this problem because it cannot solve itself. It is obvious that what has been done up to now is still insufficient in this respect, and that other measures will be required in the future. I will go further and say that, in my view, what is needed is not the more rigorous and more extensive application of measures such as those already in force at, say, Orly Airport in France. It is true that in France there is a fairly successful procedure for operating aircraft; also the timetable is fixed and even night flights are very well controlled. But these measures, of whatever kind, are all connected with the safety, and also the economic aspects, of operating aircraft. However, what is needed, and what we must try to do, is to define very soon ways of implementing new kinds of measures which would really face up to the problems which will confront us in the very near future.

What does this mean? Well, I would say that if we are to reduce the impact of the noise of civil aircraft, there must be a voluntary and inspired effort directed in two channels. First, in town planning, and the implementation of town planning, we should avoid repeating the errors made in the past over building and, in the vicinity of existing airports, we should not aggravate the situation which we already have there.

This of course is not easy, because by force of habit, economic interest and even political pressure will very often act against these attempts and offset them. But there are common-sense solutions and ways of imposing improvements by means which would be, shall we say, painless. The French delegation will express its views before the competent conference committee on how public and government authorities (for example, the Ministry of Equipment in France, which is responsible both for built-up areas and the use of aircraft) could tackle these problems on the basis of a plan, or structural scheme, sub-divided between the various departments responsible for the different aspects of town planning.

Having done this we must then authorise the development of towns, and of land, in a way which would be determined and influenced by these new building plans in which no personal, local or vested interests should be allowed to play any part.

I think this method would produce extremely good results if it were properly regulated. There are, naturally, a number of different solutions because this is a matter in which each country is able to operate in accordance with its own internal regulations. But for all of us there may be common considerations relating to aircraft noise which must be taken into account,

and standard levels which must be a basis for rules of town planning ; from these it might be possible to evolve an international framework within which those standards and plans could be applied.

I think this conference would be in a good position to explore this possibility. Now, the question of the second of the two channels to which I have referred. This second way is perhaps the more interesting one, namely how to seek together, through the pooling of all our experience and information, a solution of the following problem. It is clear that no country alone can successfully apply itself to the problem of reduction of noise at the source, that is the requirement for less noisy or more silent engines ; I repeat that no country can do this alone and I think it is something which should be approached internationally. Unilateral action would not be economically or technically possible, for obviously no builder and no airline would ever agree to penalise himself voluntarily if his competitors were to be free of any similar penalties. If there is to be a penalty in producing and operating less noisy aircraft, then this penalty must be the same for all.

We are quite clear about this, and so finally the issue is to find out whether the question of aircraft noise appears to us sufficiently serious and grave to warrant acceptance of the principle that a specification relating to the noise of an aircraft might one day condition the issue of airworthiness certificates ; and that the air passenger, who will benefit in other ways, may have to pay something more in air fares in order that take-offs and landings should become more tolerable for those who live round the airport from which aircraft leave or at which they land.

Distinguished delegates, obviously we cannot answer all the questions which arise. I have merely pointed out those which seem to us the most important and perhaps the most difficult to resolve. If, however, this conference is able, through the determined participation of all present, to focus thought on all the possible ways and means of solving this question of civil aircraft noise and the disturbance caused by it, then at least we should have many of the issues at stake very clearly pointed out. "Where there is a will there is a way", and those who have taken the initiative in convening this conference have thereby demonstrated their concern to see us tackle here with them this difficult problem of aircraft noise, and I am absolutely convinced that together, by our concerted efforts, we shall find the way toward better solutions.

I should like to offer again, very sincerely, my thanks both to Mr. Roy Mason and to Mr. Wood for the quality and great warmth of the welcome they have given us.

Thank you, Mr. Chairman.

Mr. Mason : Thank you M. Boitreaud. I now call upon Dr. Schmidt-Ott, head of the delegation of the Federal Republic of Germany.

Dr. Schmidt-Ott : Mr. Minister, ladies and gentlemen. On behalf of the Federal Republic of Germany and the German delegation, I am pleased and honoured to convey to you the greetings of the Federal Republic of Germany. May I at the same time thank the Government of the United

Kingdom for having invited our Federal Government to take part in this Conference on the Reduction of Noise and Disturbance caused by Civil Aircraft.

It is no mere chance that this conference is taking place here in London. Your country belongs to that densely populated area of North-West Europe in which about 150,000,000 live in close proximity to one another and for them progress in the field of civil aviation is as necessary to their lives as the protection of their health from excessive noise caused by civil aircraft. It is therefore natural that the initiative for this first international conference on the reduction of noise should have been taken by the United Kingdom. This statement is not meant in any way to lessen the credit for having convened such a conference. On the contrary, as a representative of a country which belongs to the same geographical area of North-West Europe as the United Kingdom, and is subject to the same problems of noise from civil aircraft, I have special cause to express to the Government of the United Kingdom, on behalf of the Federal German Republic, our thanks for its initiative. In convening this conference which, as will be seen from the list of delegates, is being attended by leading scientists, technicians and experts from all over the world, the first important step has been taken in tackling the problem of noise from civil aircraft and in trying to find solutions or improvements. Though this conference may not find those solutions, its preliminary work may have a decisive effect on future work. The results of the conference will not, as those outside it may perhaps assume, take the form of recommendations and directives to States. That may perhaps become the task of ICAO, which could base its policies on the results of this conference, and to which it is hoped the extensive material from this conference can be made available. I am therefore glad to see that the President of the ICAO Council is represented here by its First Vice-President, Mr. Ronald Dickinson, and some members of the Council and of the Secretariat. They show by their presence the interest ICAO is taking in the proceedings of the conference and they will, I hope, ensure that ICAO concerns itself in the near future even more actively with the problem of aircraft noise.

We in the Federal German Republic are well aware that aircraft noise can cause annoyance and even harm, and the opposition of certain groups of people, particularly those who live in the vicinity of airports, is understandable.

On the other hand, aviation today is a factor which cannot be divorced from the economic life of the people. In the present state of technical development in the field of aviation, a way can surely be found to protect people as far as possible from the effects of noise. In several countries where air services are operated various noise abatement measures have been investigated. But measures cannot be adopted by individual countries without affecting aviation as a whole ; that is, the aircraft noise problem, like aviation, has become an international problem and solutions can be found only on an international level. The German Federal Government considers that practicable noise abatement can be achieved by a combination of the reduction of jet noise with an intensification of the procedure in regard to the utilisation of land as well as, in particular, the restriction of building in the vicinity of airports.

It is a courageous and welcome effort that is being made here, to bring for presentation, discussion and amplification at this conference the steps which have been taken in several countries toward a solution of this noise problem. By this means a great stride is being made in dealing with the whole question. I wish to express my special thanks to the Government of the United Kingdom and my best wishes for the success of the conference.

Mr. Mason : Thank you Dr. Schmidt-Ott. I now call upon Mr. Shepanek, head of the delegation of the United States of America.

Mr. Shepanek : First of all I would like to say that I am very pleased to be attending this conference on aircraft noise alleviation. It is a timely subject and a complex problem which, as it exists today, represents a serious barrier to the future growth of aviation.

In the United States the seriousness and urgency of the problem has been recognised at the highest level of Government. I would like to quote from the President's Transportation Message of 2nd March of this year, wherein President Johnson said :

Aircraft noise is a growing source of annoyance and concern to the thousands of citizens who live near many of our large airports. As more of our airports begin to accommodate jets and as the volume of air travel expands the problem will take on added dimensions . . . It is clear that we must embark now on a concerted effort to alleviate the problems of aircraft noise.

During recent years we in the United States, that is the aircraft manufacturers and operators, the pilots, the airport operators and the Government, have individually devoted considerable resources to noise alleviation. More recently we have embarked upon a collective effort to limit aircraft noise, both now and in the future, to a level that is consistent with the activities of communities in airport neighbourhoods.

Our programme is based on the recommendations contained in the White House Report entitled *Alleviation of jet aircraft noise near airports** published in March 1966. This report can be made available to interested participants. We are seeking a solution to the problem on three broad fronts : the aircraft itself ; where it flies in the vicinity of the airport ; and the use of the land in the airport neighbourhood which is consistent with airport operations.

We are continuing and expanding our research to produce quieter aircraft. We have requested from the Congress authority to use noise criteria as a condition of the issuance of a type certificate for aircraft. We are trying to further refine flight operational techniques and traffic control practices, and we are looking at every means to make the community in the vicinity of the airport compatible with the residual aircraft noise that we cannot eliminate.

Our programme seeks a lasting solution. Such an ambitious goal cannot be obtained quickly or easily or cheaply. We are, at this point in time, still in the formative stages of the programme. I mean to imply here that we, as a Government, have not prejudged any means of solving the problem. We hope that the exchange of views at this conference will help us.

*US Office of Science and Technology. Jet Aircraft Noise Panel. *Alleviation of jet aircraft noise near airports*. (Washington, Government Printing Office, 1966.) \$1.25.

Our delegation is composed of a wide variety of interested parties from both Government and industry. They will participate in the several specialist committees of the conference as individual experts in many related areas such as science, engineering, law, operations, economics, human factors and management. I want to emphasise that they will be expressing their own views. We have made no attempt to reach a unanimity of view, and consequently there is no official delegation position, nor is any delegate authorised to reflect the official views of the United States Government. The same must be said of the papers which have been presented by the United States participants. These too represent the views of their authors and not necessarily those of the United States Government.

Mr. Chairman, we thank you and your Government for this unique opportunity to exchange views on this pressing problem.

Mr. Mason : Thank you Mr. Shepanek. I now call on Dr. Fischer, head of the delegation of Austria.

Dr. Fischer : Mr. Chairman, ladies and gentlemen. It is a great honour for me, as head of the Austrian delegation, to express the acute interest which we have in everything concerning the struggle against traffic noise. The Minister of Transport—on whose behalf I am now speaking—is greatly interested in the work that will result from this conference. We are quite aware that, though this struggle against aircraft noise is not the only problem arising from traffic noise, it is one of the most important. Thus, though we must, for example, remember that the European Conference of Ministers of Transport has set up a special committee for studying the overall problem, the rapid development of civil aircraft has caused this question of aircraft noise to become a really urgent one.

For Austria this has another aspect because, as you will be well aware, it is a country where there are great numbers of tourists coming at all times of the year. Therefore aircraft noise in Austria plays a particularly important part for our people, because we know that tourists who wish to have a rest would obviously wish to have a peaceful atmosphere in which to relax. When we remember that in the course of our daily work, noise is an inevitable adjunct and that even when we are trying to relax, for example, in the mountains far from urban areas—we are still pursued by aircraft noise, then we realise that this is a problem we must tackle.

Perhaps I might touch on the supersonic noise problem and here there is satisfaction in the fact that we have begun to take steps and to consider what can be done about that problem. Technical advances will, of course, give us ever-increasingly fast and comfortable means of transport, but none the less we can also use technical know-how in reducing the nuisance which is becoming ever greater.

Obviously some people may say that we must get accustomed to noise ; with time possibly this could be true to a certain extent. We can get used to anything "to a certain extent", but the doctors tell us that, even where habit has made us accustomed, it does not necessarily mean that health is not harmed.

On the international level the International Anti-Noise Association has, for example, convened conferences to study the technical, physiological and

technological aspects of the problem ; I hope that their efforts have been helped by participating nations. I particularly wish to thank the Government of the United Kingdom for the initiative they have taken in encouraging international action.

Thank you very much.

Mr. Mason : Thank you, Dr. Fischer. I now call upon Captain Frankum, head of the delegation of The International Air Transport Association.

Captain Frankum : Mr. Minister, Chairman, ladies and gentlemen. As chief delegate of the International Air Transport Association, which represents all the major airlines of the world, and on their behalf, permit me to extend sincere thanks and gratitude to the United Kingdom for sponsoring this International Conference on the Reduction of Noise and Disturbance Caused by Civil Aircraft.

For too many years the airlines have suffered the wrath of our airport neighbours and the confusing, inconsistent efforts of local authorities and airport operators to control noise. It is significant that this conference includes, among others, delegations from governments of many countries of the world. Hopefully this indicates a growing awareness that aircraft noise is not just a problem for the airlines but is a problem affecting the entire economic community of the world and the solution, as well as the appropriate allocation of cost for the solution, should be shared by the entire economic community.

IATA strongly supports the statement that the conference is not intended to reach agreements. We consider this conference primarily as an exchange of views from which no firm decisions or conclusions should be made at this time. Undoubtedly, many statements or excerpts from working papers taken out of context may mislead this conference and the general public into believing that immediate relief and a solution are just around the corner.

IATA supports the opinion that technological and operating procedures alone cannot solve the aircraft noise problem. It will require the complete understanding and co-operation of all segments of the community and the active participation of governments at the highest level.

It is essential that the issue of who is responsible for regulating noise and controlling air space be resolved as soon as possible.

In the months to come, perhaps as a direct result of this conference, many forums will be established to consider further the aircraft noise problem and the airline industry is looking forward respectfully to full representation in such forums.

Once again, Mr. Chairman, let me thank you on behalf of the International Air Transport Association for allowing us to participate in this conference and for having this opportunity to say a few words. Thank you.

Mr. Mason : Thank you, Captain Frankum of IATA.

Gentlemen and visitors. As Chairman and host Minister, I appreciate the sentiments that have been expressed by the speakers during the course of this morning. What has been said already, and the keenness of the views expressed, I think augur well for the conference.

I should like also to thank at this stage the delegates who have consented to be Chairmen of the six committees. This was agreed upon at a meeting of heads of delegations during the course of yesterday afternoon. It may prove an onerous task; it may prove tiring, but I hope it will prove fascinating. I wish you all success in your efforts.

Gentlemen and visitors, thank you very much indeed for attending the opening session of this conference. It is now my intention to adjourn the conference and allow the committees to reassemble at three o'clock this afternoon for the really serious part of their work—three o'clock this afternoon and two-thirty in the afternoons thereafter.

Thank you very much indeed for your attendance. Good luck to all of you who are going to participate in the conference.

APPENDIX B (*Contd.*)

Records of the Plenary Sessions

2. The Closing Plenary Session

Wednesday 30th November 1966, 14.30 hours

The Long Gallery, Lancaster House

*Chairman : Mr. Roy Mason, MP, Minister of State Board of Trade
United Kingdom*

Mr. Mason : Gentlemen, before inviting the Chairmen of the committees to present their reports I should like to say how much we welcome Mr. Binaghi, President of the Council of the International Civil Aviation Organization, who is present this afternoon, Mr. Binaghi will address the conference after the presentation of the committees' reports and I am sure we are all looking forward with great interest to what he has to say.

I shall now proceed to the business of this afternoon's conference and ask the Chairman of Committee No. 1, Mr. Harvey Hubbard, to present his Report.

Mr. Hubbard : Mr. Chairman and fellow delegates, I would first say a brief word of appreciation to Mr. Derek Higgins our technical secretary, and to Mr. Peter Lloyd, our rapporteur, both of the United Kingdom delegation, and to the appropriate members of the technical staff of the conference for the preparation and the distribution of our report.

On behalf of Committee No. 1 I am pleased to present the following highlights from the report of that committee. We are gratified to note that in France, the United Kingdom, the United States and the USSR active and comprehensive research programmes and studies are going on in the field of reducing noise from engines and aircraft. The committee wishes to re-emphasise the importance of continuing research on aircraft noise and of maintaining co-operation between the countries concerned.

The papers presented to us indicate that in the field of power plant design there are a number of techniques under investigation and development which hold out prospects of noise reduction at the source. The trend to higher by-pass ratios for subsonic aircraft is already reducing the amount

of noise from a propulsive jet. With engines of this type the main noise source is the fan and emission from this can be limited by such measures as reduction of tip speed, adjustment of spacing of blade rows, choice of numbers of stationary and moving blades, and by use of sound absorbent linings.

Another characteristic of the fan engine is the fact that the discrete frequencies generated by the fan, which can be influenced by design, make the quality of noise increasingly important from the subjective point of view.

In the field of aircraft design the scope for noise reduction is less obvious but there may be some further benefit to be derived from the known technique of moderating noise under the climb path by installing more thrust to achieve a higher initial rate of climb and by power reduction after the initial climb.

Aircraft could also be designed to make possible a steeper angle of descent at lower levels of thrust, if this is operationally acceptable, so as to reduce the noise levels under the approach path.

But with increase in aircraft size some of these techniques will now be used to avoid the increase in noise level which would normally accompany this trend. Furthermore, the design changes aimed at noise reduction are likely to involve some penalties in operating costs. The magnitude of the penalty for a given noise reduction was considered in one of the papers presented to us but it cannot yet be assessed with certainty. What is certain is that in the competitive world of air transport undoubtedly an operator cannot afford to pay any significant penalty in quieter aircraft unless his competitors do the same.

For this reason there is general support in Committee No. 1 for the view that, in order to make worth-while progress, it will be necessary by a process of certification of new aircraft to ensure that these conform to improved noise standards. Certification of aircraft for noise characteristics would also have the advantage of providing realistic goals for the engine and aircraft manufacturers, and would make possible more reliable predictions of community noise exposures.

What the extent of the improvements in noise characteristics should be, or within what time scale it might be realised, are questions that now need to be resolved. But some of the papers presented to us indicated that worth-while improvements should be possible without excessive economic penalties.

There are, however, three reservations which the committee wishes to make. The first one concerns supersonic transport aircraft. These require very large engine powers and cannot use the lower exhaust velocities appropriate to subsonic aircraft. In spite of certain compensating advantages, such as variable power plant geometry and a very high rate of climb, it should be recognised that these aircraft present a special problem, especially as regards lateral noise at take-off.

The second reservation concerns existing aircraft, the substantial improvement of which is bound to be more difficult than in the case of new designs, and which is bound to introduce economic penalties on a greater and perhaps prohibitive scale.

The third reservation is that acceptance of the principle of bringing about a reduction of aircraft noise at the source by a process of certification must not lead to a failure to exploit other possible approaches. It is suggested that these other approaches should be vigorously pursued at the same time as being equally important to the solution of the overall problem.

The more complete Report of Committee No. 1 is contained in the written version which was approved unanimously by the committee and which has been submitted to the conference secretariat. Thank you very much, Mr. Chairman.

Mr. Mason : Thank you, Mr. Hubbard, for that report. I will now call upon Mr. Willoch of Norway to give the report of Committee No. 2.

Mr. Willoch : Mr. Chairman, ladies and gentlemen. On behalf of Committee No. 2 I have the honour to present their report to this meeting. The noise abatement methods considered by Committee No. 2 have as their objective the securing of distance between airports and their normal associated activities on the one hand, and residential and any other noise-sensitive areas on the other.

When considering the practical application of these methods it is readily apparent that one is dealing with questions of airport and land-use planning which are in most cases of a complex nature, this being so for a number of different reasons. Practical planning of this kind must take into account the question of alternative and supplementary noise abatement methods. There are frequently very important conflicting planning factors to be considered. The overall cost factor is as important as it is difficult to assess. And the tools which we have at our disposal are unfortunately not always quite adequate.

It is definitely not in an attempt to wash our hands of the problems, but to try to give a fair account of their scope and nature, that we have attempted, in an introductory chapter in our report, to define the problems and to place them in what we believe is their proper context from a planning point of view.

Apart perhaps from some obvious cases, our first requirement in the way of tools for planning purposes is some useful means of identification of noise-sensitive areas around airports. The subject matter has, of course, been dealt with by Committee No. 4 but we have in our report made some observations on this question from the point of view of Committee No. 2. We have among other things found it appropriate to mention briefly the assessments of this kind which have already been carried out, or are contemplated, as reported to the committee. In this connection we have pointed to the important, even if rather self-evident, observation that the adoption of methods at present available, in places other than those where the social survey work supporting them was carried out, is liable to error. This leads, we believe, to the practical conclusion that establishing a relationship between the methods at present available can be of some limited practical value in the way of first aid. However this may be I do not think it can be disputed that we on the planning side are in need of some advice in this respect. We realise, though, that this cannot be attempted in terms of concrete assessments at this conference.

I should also like to mention here in this connection that we have in a communication to Committee No. 1 expressed the interest we take from a planning point of view in the question of certification of aircraft. The possibility of more accurate predictions in this connection is the direct concern of Committee No. 2.

Noise zoning may lead to land zoning, which again calls for control of land uses, and we have in my committee looked into the question of land use control. It has been quite impossible to convey in the report the great interest we have taken on the committee in discussion of an exchange of information about these questions, which are of course of the greatest importance in assessing the possibilities which we have of doing anything useful in the way of noise abatement in this field. The reasons why are explained in the report.

May I just mention briefly here that we have had to deal with legal questions, where the complexity and variety between the countries represented are as pronounced as the importance of the subject in practical planning. We have discussed, as is reflected in the report, the question of altering established land uses—this with rather pessimistic results—and the question of preserving existing compatible uses and enforcing compatible development in the future—this with greater optimism. We do hope however that it has been reflected in the report, in the rather cautious way which we think appropriate in this connection, that we are not in all countries completely satisfied with the tools offered to us in this respect, even though we fully realise and accept the definite limits set by legal principles and traditions in each country.

The report reflects the opinion of the committee that co-ordination between civil aviation and other planning authorities at all levels is of the greatest importance for effective noise abatement planning of the kind dealt with by our committee, and furthermore that we attached great importance to a continued international exchange of information, ICAO being perhaps in a position to play a useful role on some aspects of this question.

May I, Mr. Chairman, conclude my presentation of the report of Committee No. 2 by quoting from it a passage which, in very general terms, sums up the present situation in the field of noise abatement with which we have been dealing:

The discussions of our committee have shown that action on the lines with which we have been concerned can be of definite, but in some cases limited, use particularly for new airports or those airports which are at an early stage of development. Much greater difficulties are likely to arise, however, at existing airports of a major character, where the volume of traffic is large and where the environment is already heavily developed,

and as we all know we have unfortunately quite a number of cases of that type around in different countries.

May I end by saying that there are of course deficiencies in the report; and I would like in conclusion to mention one in particular. We on our committee have found this conference interesting and valuable to a much greater extent than it has been possible for us to convey in our report. Thank you, Mr. Chairman.

Mr. Mason : Thank you very much indeed, Mr. Willoch, for that report. I would now like to call upon Mr. Falkenhagen, of the Netherlands, who will present the report of Committee No. 3.

Mr. Falkenhagen : Mr. Chairman, ladies and gentlemen. Although many different viewpoints were represented in Committee No. 3, we have been able to agree unanimously on a report which is positive and, we trust, useful. The committee discussed more than a dozen papers, and concluded that operational noise abatement procedures had made, and would continue to make, a significant contribution to the alleviation of nuisance caused by aircraft noise. The committee was of the opinion that the effort to develop new ideas and new techniques should continue, so that operational procedures might in the future make a greater contribution to noise abatement. Nevertheless, we agreed that, for current aircraft and facilities, there was little more that could be done in many cases without a degradation of safety, and we must look, for an increasing contribution, to quieter aircraft and to compatible land usage.

Much of the report records the exchange of views, and current practices, in connection with such matters as preferential runways, take-off and climb-out procedures, minimum noise levels for approach and landing procedures. Discussion highlighted the common point that, in general operational procedures, noise abatement will be more effective and more willingly accepted if adequate and appropriate ground facilities and aircraft equipment and instrumentation are provided. We were informed about work undertaken in the United States on approach procedures, specially aiming at much steeper approaches with low power, resulting in an important reduction of the noise during approach. We welcomed these investigations, but with some caution in view of the safety factors involved. We heard also with much interest of experiments in progress with a standard take-off flight profile for use by all jet aircraft. Other suggestions were made as to profitable lines of research and development. It was noted with interest that some countries are now including in aircraft flight manuals limits within which noise abatement techniques can be safely carried out.

The committee also had before it a request that comprehensive data on aircraft noise characteristics should likewise be included in the flight manuals.

Finally, dominating our whole life as a committee, has been the principle that safety must not be neglected. We hope that our exchange of views and discussions will help in some degree toward a generally acceptable solution of the aircraft noise problem.

Mr. Mason : Thank you very much indeed, Mr. Falkenhagen. I will now call upon M. Joubert to present the report of Committee No. 4.

M. Joubert : Mr. Chairman, ladies and gentlemen. The matters allocated to Committee No. 4 were the 'methods of specifying maximum permissible noise levels, how such levels should be determined, and methods of assessing compliance'. This summary brings out only the highlights of our discussions, which are covered more fully in our report.

As regards 'methods of specifying maximum permissible noise levels', the committee were pleased to receive an announcement from the delegate of the International Organization for Standardization of the publication just before

the Conference of ISO Recommendation No. 507, *Procedure for describing aircraft noise around an airport*. This gave, for the first time, international recognition to the Perceived Noise Level in decibels—the PNdB. The consensus of the committee was that, for aircraft noise, the Perceived Noise Level is the best available predictor of the subjective attribute of 'noisiness'; and that it should be used where the highest accuracy is needed. The committee recognised, however, that some modifications will be needed to take account of such factors as duration and the presence of pronounced pure tone components. It was hoped that the ISO would proceed to specify these.

Before going on to consider how maximum noise levels should be determined, and how compliance should be assessed, the committee discussed the general problem of the control of aircraft noise. At the opening plenary session of this conference the chairman (Mr. Roy Mason), M. Boitreaud the leader of the French delegation, and Mr. Shepanek, leader of the United States delegation, referred to the idea of using noise criteria in the certification of aircraft. Early in the conference, Committee No. 1 also drew our attention to the importance which they attached to that idea. Committee No. 4 unanimously agreed that it was of the utmost importance to introduce as soon as possible a system of noise certification of aircraft, including the specification of appropriate operating procedures. Not only was this necessary to ensure that future aircraft would be designed from the outset to be less noisy and that, where at all practical, retrofit measures might be taken, but it would also provide the data on the noises to be expected in the future, which are necessary as a proper basis for planning land usage, particularly in the neighbourhood of new or expanding airports.

The committee appreciated that the effect of a system of noise certification would not be immediate but progressive. We also appreciated that there would be many problems to solve before a practicable system could be brought into effect. Both these matters are referred to in our report. The committee thought the national administrations principally concerned should press forward with studies of all the relevant issues, working closely with ICAO, which had an important role to play. We noted that the Fifth Air Navigation Conference of ICAO intended to consider aircraft noise in the autumn of 1967.

The committee discussed at some length the basis on which maximum permissible noise levels should be determined. We recognised that these maxima must be a compromise representing, ideally, an optimum taking all factors into account, so that the economic and social burdens are distributed equitably. Much further study needed to be done before such an ideal could be attained. In the meantime, the urgency was such that the noise limits for a system of noise certification would probably have to be decided in the first place on the basis of a judgment as to what constituted a substantial reduction compatible with what is possible.

The committee considered a number of other matters within their terms of reference, including such important items as methods of assessing total noise exposure, noise monitoring and some legal aspects. These are covered in our report. Reviewing all the work of my committee during this conference, perhaps our most important conclusion may be summarised in this way. A

system of noise certification of aircraft is urgently required, and the science of acoustics is sufficiently advanced that the associated problems of measurement and assessment are largely solved. Thank you, Mr. Chairman.

Mr. Mason : Thank you, M. Joubert, for that report from Committee No. 4. I will now call upon Mr. Alsop, of the United Kingdom, to present the report of Committee No. 5.

Mr. Alsop : Mr. Chairman. I have the great honour to present the report of Committee No. 5, and with your permission I would like first to clear one small point of omission in the report itself. This is that, on page 2 of the English version of the report, the words 'in Japan' should be added at the end of the fourth line. Paper P.5 was in fact submitted by Japan, and the regulations referred to apply only in that country. [*Note from Secretariat : This amendment is incorporated in the report of Committee No. 5 at Appendix C.*]

Sound insulation against aircraft noise is only a part of the whole field of sound insulation against noise external to buildings and against noise within them, although of course it is an important part of that whole field. We did not therefore think that our report was the place for a detailed discussion of current sound insulation practice. This is reasonably widely known and is enshrined in text books and codes of practice in various countries. Nevertheless the whole of our report should be seen against the background of the present state of knowledge of the way in which sound is transmitted through materials.

At present the only defence against airborne sound, from whatever source, that is at all understood is in fact mass. We know broadly speaking the way in which sound insulation varies with mass and we know how heavy a construction must be to achieve a specified sound insulation. This is the so-called mass law. It is this existing knowledge that lies at the back of the design guide approach summarised in one of the United States papers and that we welcome in the first major point mentioned in page 1 of the report. This design guide approach leads to a determination of the acoustic treatment of any type of building exposed to aircraft noise of any level. Our United States colleagues emphasised the tentative and empirical nature of this approach, and that these conclusions were so far untried. We nevertheless welcome it and think it well worth study by other countries.

But the present state of the science of sound insulation underlines not only this first point. Modern building practice in practically every country has moved, and is continuing to move, towards construction methods that set a premium on lightweight components, perhaps especially those used for external walls. There is a great need, as we see it, to pursue research into the whole field of sound insulation in relation to lightweight construction in an effort to break out of the mass law situation as we know it at present. We need a deeper knowledge than we have of the physical laws of sound transmission, especially through panels, in order to design lightweight panel systems that will provide a cheap and adequate barrier to sound. Those who are expert in the field would say, I think, that the situation is not unhelpful.

There is also a possible lead referred to in the fifth of our points, to ensure that the constructional method used in a building erected in an area that is noisy now, or that is likely to become noisy, does not prejudice the easy application of sound insulation, for example by means of double windows, when this becomes necessary or desirable later in the life of the building. It is well worth considering whether the external walls should now be designed with this need in view.

The need for further research to which I have referred, and a great deal is already in progress in many countries, is also the concern of our second and third points. There may be, with some forms of construction, an at present unknown bonus of sound insulation depending on the angle of incidence of noise. Although the chances are that the bonus may be small, and that the practical application of such a finding will be limited, more research would clearly be valuable.

At least as important as all this is the need for research that will lead to a correlation of laboratory and field measurements of sound insulation. At present there is no certainty that a novel constructional system, having adequate sound insulation when tested in the laboratory, will achieve the same standard when incorporated in an actual building, and this needs a good deal more understanding.

I have left until the end two other matters. First, the United Kingdom scheme for helping householders near London Airport to pay for sound insulation works. All I will say is that, although the scheme raised some interest, there seemed to me as Chairman to be no violent rush yet to be the second country to adopt such a policy. Other countries saw difficulties peculiar to their own circumstances. Second, the concern of the committee to emphasise that sound insulation of buildings can only treat part of the problem that affects the total living environment.

May I conclude, Mr. Chairman, by expressing my sincere thanks to the members of the committee for their participation in these proceedings.

Mr. Mason : Thank you very much indeed, Mr. Alsop. I will now call on Mr. Donaldson of the United Kingdom to present the report of Committee No. 6.

Mr. Donaldson : Mr. Chairman, Delegates. Committee No. 6 was charged with conferring and reporting on the problem of noise nuisance in the vicinity of airports caused by aircraft engines being run up for maintenance purposes. I am indebted to all delegates in my committee for their valuable contributions. In presenting our report I should like first of all to make the following observations.

The subject of noise made on aprons by auxiliary power units installed in aircraft was raised by several delegates. While not normally associated with running up for maintenance purposes, we decided to discuss the subject and have mentioned it in our report. There was some doubt as to whether the effect of noise on persons within an airport was appropriate to our discussions. As it seemed to form a natural link in the chain, we have included it. We have endeavoured to avoid detail in the report, leaving it to be studied in the relevant papers by those to whom it may be of special interest.

I have attempted to summarise our report as follows. Noise nuisance created by aircraft running up for maintenance purposes has its own special characteristics which may well call for special measures to curb it. Apart from the annoyance caused to communities living near airports, the nuisance to persons working on airports, and perhaps to passengers, could be considerable, and necessitates appropriate action by airport authorities and airlines. My committee felt that the need for national legislation which would deal with the question of responsibility for undue noise nuisance was beyond their scope.

We notified Committee No. 2 of our interest in the control of development around airports. The committee agreed in general that co-ordination of measures to deal with noise nuisance should be vested in a single authority, probably the airport authority. Some delegates informed the committee that at their airports the individual airline was presently held responsible.

The committee reviewed the various devices and procedures by which noise nuisance can be reduced and the degree of success achieved or achievable. They considered the effect of noise measures on airlines' economy and were given actual figures in respect of certain airlines.

The effect which meteorological conditions can have on the intensity and propagation of noise was studied and the possibilities of using meteorological forecasts to abate nuisance were considered. No practical application of the knowledge could be envisaged at this stage.

The need for noise criteria, which would enable an airport authority readily to prescribe what measures should be taken, was appreciated. So were the difficulties involved. It was agreed that every airport would have to be studied individually and that the measures taken at one airport could be either excessive or inadequate at another. The broad criterion of endeavouring to keep noise as near as possible to the ambient noise at the vulnerable locations around an airport was noted.

Finally the committee continually stressed the ultimate aim of reducing noise at source and of encouraging measures for the further abatement of nuisance, while not placing unbearable economic penalties on airlines. Thank you, Mr. Chairman, Delegates.

Mr. Mason : I now have great pleasure in calling upon Mr. Binaghi, President of the Council of ICAO, to address us.

Mr. Binaghi : Mr. Chairman and Minister, Delegates. I am very glad to attend this closing plenary of the conference and it is an honour for me to address such a distinguished audience.

We in ICAO had no doubt that the conference constituted a very timely undertaking and that it would contribute greatly to a better understanding of the problem of noise and disturbance caused by aircraft. The results of the deliberations of the different committees, which we have just heard presented by their chairmen, have proved this.

I wish therefore to join those who have previously congratulated the Government of the United Kingdom for convening this conference. Of course it is not to be expected that the conference would find a solution to the problem. It is too much of a complex subject to be solved so easily. But

I believe that all those who attended the meeting, and all those who, later, will read the reports, will confirm what you, Mr. Minister, said in your opening remarks one week ago, namely 'that all methods of controlling aircraft noise must be investigated, and that only by attacking the problem from all sides are we likely to achieve the substantial improvements we all desire'.

Many efforts, nationally and internationally, will be needed in the future to obtain that improvement.

Where the problem already exists, action by the authorities responsible for airports, and for regulations applying to the land surrounding those airports, will continue to be essential in improving the present situation. In the case of airports where the problem has not yet arisen (and there are still many airports in this fortunate position) the responsible authorities should take immediate steps to avoid the erection of houses or certain other buildings in the critical areas. In many cases this will not be easy because of local financial and political interests, but it would be foolish to ignore the potential future difficulties and not to eliminate them while there is still time for so doing.

In the international field, I am certain that ICAO will do its best to assist governments in their efforts to minimise or reduce the disturbance caused by aircraft noise. It is today too early to say what ICAO could do but, on a personal basis, and without committing my Organization or trying to influence your conclusions, I dare say that there are at least three aspects where international action through ICAO would seem desirable.

In the first place, the recommendation of the International Organization for Standardization might be supplemented by ICAO. We need as wide as possible international agreement on what to measure, how to measure it, and what other factors to take into account, such as the number of exposures, the duration of each exposure, sound frequency, etc.

Secondly, the inclusion of noise as a factor in the certification of an aircraft is the direct concern of ICAO. Once the time is mature for ICAO's action then we shall have to proceed rapidly because of the protection given by Article 41 of the Chicago Convention to existing aircraft or prototypes.

The third aspect I have in mind is the need to provide information and sound advice, supported internationally, on zoning regulations for the utilisation of land at the ends of runways. Any ICAO advice on the subject will, naturally, only be addressed to national governments, but each of them should, in turn, make the material known to provincial and municipal authorities and to local interested parties.

As I said before, these are only personal ideas. I understand that, with the agreement of heads of delegations, the United Kingdom intends to process the results of this conference and that ICAO may expect to be officially approached in due time by one or more governments. You may rest assured that the ICAO Council will not waste time in starting action. Thank you.

Mr. Mason: Thank you very much, Mr. Binaghi. Notice has been given to me that a number of heads of delegations would like to make statements before we conclude the conference. I now have pleasure in calling upon M. Joubert of France.

M. Joubert : Mr. Chairman, ladies and gentlemen. May I first of all offer apologies on behalf of M. Boitreaud, Secretary-General of Civil Aviation, who had hoped to be present at this closing plenary session, but who has, unfortunately been unavoidably detained in Paris.

As the International Conference on the Reduction of Noise and Disturbance caused by Civil Aircraft comes to an end, a conference which has allowed us to make so many useful and friendly contacts, and to have such a fruitful exchange of ideas, and which has given rise to discussion always interesting and sometimes vehement, it seems clear to me that it will be necessary from now on to add the problem of noise to the traditional factors relating to air transport; safety, regularity, speed, comfort and price. There is room for discussion about the order in which one lists these factors, always provided that safety comes first. I wonder, however, whether the problem of noise has not reached the point today when it can claim a place immediately after safety; no one I think would contemplate dislodging safety from its place at the top of the list.

That at least is the impression I gain from the discussions in which I have taken part. And I am struck also, and at the same time encouraged, by the fact that all countries, in spite of the difference between them, faced as they are by the same basic problems, have tackled them by methods often very similar, to such an extent that it has been fairly easy at this conference to reach common conclusions of importance.

Without going back over the content of the committee reports I should like to emphasise again the unanimity of view expressed on the need for a measure, about which many have been thinking for some time, which consists in making the certification of aircraft subject to conditions relating to noise. And it has been recognised that, without any wish to impinge on the right of each country to take an initiative, the conditions imposed needed to be, for all practical purposes, uniform. This leads naturally to the thought that the organisation admirably fitted to give uniform shape to these new conditions is the International Civil Aviation Organization which is accustomed to the promulgation of standards and recommended procedures on an international scale. There is no doubt that the suggestions put forward by this conference will assist and hasten the introduction of noise standards into Annex 8 and, perhaps, into Annex 6 of the Convention relating to international civil aviation.

All this goes to emphasise how right the United Kingdom Government were in having called this international conference and how much we are indebted to them for doing so. I should also like to say how much the French delegation have appreciated the excellent organisation of the conference, the efficient work of the secretariat, the invaluable assistance given by the British delegates who acted as rapporteurs and technical secretaries in the committees, the difficult task so intelligently carried out by the interpreters and finally all the facilities which have been made available to us in this delightful palace of Lancaster House. We shall take away with us, with very pleasant memories, an excellent programme of work. Thank you, Mr. Chairman.

Mr. Mason : Thank you very much indeed, M. Joubert. I would now like to call upon Mr. Harper of Australia.

Mr. Harper : Thank you, Mr. Chairman. I am very grateful for this opportunity of offering our sincere thanks and our appreciation of the general work of the conference. We have not contributed very much to this meeting, but on the other hand we have gained a great deal. This is in large measure due to the very successful and efficient arrangements that were made for the conduct of the conference and to the warmth of the hospitality. We shall take home a great deal of valuable information, and I hope that in the future our contributions will be more active. Thank you, Mr. Chairman.

Mr. Mason : Thank you very much, Mr. Harper. I would now like to call on Mr. Munin of the USSR.

Mr. Munin : Gentlemen. In the name of the Soviet delegation, I would like to express our sincere appreciation to the United Kingdom Government for having sponsored this conference. The problem we are struggling with, aircraft noise, is very vital, and present-day life requires that, where aircraft are operated, there must be measures to restrain noise. Our conference is one of the first steps in achieving such an objective, and the exchange of ideas gives us a clearer view of how complex and urgent the problem is. We have found the fruitful exchange of information from various countries, dealing with this problem of aircraft noise, very valuable. The usefulness of this conference is self-evident, Mr. Chairman, and we look forward to the publication of the official proceedings of the conference at a later date.

I would like to thank the United Kingdom Government for this conference and for its timeliness, and to say how pleased we are with the excellent organisation. We thank all those who have taken part in the conference.

Mr. Mason : Thank you very much indeed, Mr. Munin. I will now call on Mr. Shepanek of the United States.

Mr. Shepanek : Mr. Chairman, Delegates. The expression of views provided by the six committees of this conference represents the combined and individual work of over 200 of the world's experts on the aircraft noise problem. In our view this has been the best and most profitable exchange of views that has yet taken place. It has served to crystallise, to postulate and to clarify many aspects of the problem.

A clear understanding of the total problem is essential to all interested parties, both governments and industry, in order to provide a basis for the co-operation necessary for the systems approach solution—that is the control of the noisiness of the aircraft, the flight path and the use of land compatible with aircraft operations. An example of the progress we have made here is the common understanding reached by the committees concerned on the need for certification of aircraft with respect to noise. We feel certain that the work done by the committees will provide much useful guidance for national and international efforts in aircraft noise abatement.

On behalf of the United States delegation, I would like to express our very sincere appreciation to the delegates of all the countries participating in this conference, the delegates of the several organisations, and to the United Kingdom for their organisation and support of the conference. Thank you, Mr. Chairman.

Mr. Mason : Thank you very much indeed, Mr. Shepanek. I now call upon Mr. Kouba of Czechoslovakia.

Mr. Kouba : Mr. Chairman. Thank you for inviting the Czechoslovak delegation to take part in this conference. We have much appreciated this opportunity to assist in the conference and to make new and interesting and important contacts. All the members of the Czechoslovak delegation are in London for the first time, and it is an excellent opportunity to get to know something about your country and people. It is one of the best ways for promoting friendship among the nations. We were deeply impressed. We were also impressed with the splendid organisation of the conference. This has marked a new step toward a satisfactory solution of the noise problem, and also toward fertile international co-operation and friendship. We wish much success and good luck to you. Thank you, Mr. Chairman.

Mr. Mason : Thank you, Mr. Kouba. I now call upon Professor Bürck of Germany.

Professor Bürck : Mr. Chairman, ladies and gentlemen. Delegates from many countries have come to this conference to present their differing views. The conference has dealt with the technical discussion, and close examination, of highly technical and urgent problems—problems affecting a world criss-crossed by transport, a major element in which is air transport. Yet, in spite of many languages, we have, at least on the technical plane of the organisation and procedures we have discussed, spoken only one language, ladies and gentlemen. Thus it is that we have been able to make great progress during this London conference and we have been very much helped by the provision of simultaneous interpretation. We, in the German delegation, would like to express our sincere thanks for all the assistance we have received through German interpretation. We have learned much. We have seen that there is a common will, a will and a way; and that this will finds a way even in a field which gives to some the impression of being an impenetrable jungle.

I must mention too the value of the personal and human contact which can develop during discussions such as we have had, and which contributes greatly to the improvement of mutual understanding in dealing with common problems.

Thanks to the excellent organisation and thanks to the cordial hospitality which we have received here in London, this conference has been an unqualified success and affords a basis for the hope that we shall have further successes in the field of international co-operation which has been outlined here; for the subject with which we have been dealing is one of great importance to people at large.

In the name of all of us in the German delegation I thank those who have done so much to contribute to the smooth running and success of this conference, from the Minister, the chairmen of committees and the Secretary-General, to the people in the background, including the interpreters who have played their part in achieving success and mutual understanding in examining our problem. This is wonderful co-operation and I would like to say thank you and au revoir.

Mr. Mason : Thank you, Professor Bürck. I now call upon Mr. Killip of the International Air Transport Association.

Mr. Killip : Mr. Chairman, ladies and gentlemen. Closing speeches at a conference like this tend to become a bit formal, so the shorter they are, the better. But as the world's airlines are the owners of the machines which make the noise, it would perhaps be appropriate if I, as spokesman for IATA, were to make some comment.

For some years the airlines have been increasingly worried that the whole burden of doing something about the noise problem has appeared to be thrown on their shoulders. The attitude appeared to be developing that, because noise is a nuisance, the airlines themselves are a nuisance, to be tolerated up to a certain point but no further.

We felt that this was tending to obscure the basic reasons for our existence. We fly where we do because particular communities have decided, in the interest of their economic and social well-being, that they must have air services linking them with other communities. To meet this need they have provided airports. For the last ten years the contemporary machine by which air services are provided has been the jet aircraft.

It is clear that in providing airports, the community must take into account the characteristics of the air services provided and so arrange matters that the airport can exist in reasonable harmony with its neighbours. The airlines cannot do this; normally we have no say in the location of airports, and certainly we have no say in the planning activities of local communities. So when the complaints are loudest, perhaps we may be forgiven if we feel it a little unjust that the whole of the criticism should be directed at us.

That is why we have been tremendously encouraged by this conference. We feel that there has been a general willingness to approach this very serious problem on the basis that it cannot be resolved simply by advanced aircraft technology and operating procedures; the search for a solution, and the costs involved, need to be supported by the entire economic community.

We deeply appreciate the invitation to attend this conference, Mr. Chairman, and we hope that our contribution to the discussion has been helpful. There will undoubtedly be further discussions on this subject, both internationally and nationally, and we hope that the International Air Transport Association will be invited. In all cases we offer to do all within our power to assist in solving the problem.

Thank you, Mr. Chairman.

Mr. Mason : Thank you indeed, Mr. Killip. And now I finally call upon Professor Atteslander of OECD.

Professor Atteslander : Mr. Chairman, ladies and gentlemen. First I would like to join other speakers in thanking and congratulating those who took the initiative in calling this conference. They are being rewarded by the fact that most certainly the results of the conference have gone well beyond the expectations of many of us.

Second, during the deliberations, I noted with gratitude that the work of the OECD study groups on the abatement of aircraft noise, which was started more than eight years ago, was duly acknowledged. This work will

be carried on. It is hoped that the results of the social surveys I am referring to, which were carried out in different countries, will be made public by OECD within the next year. We do not attempt to offer easy solutions to the most complex problems of human reaction to aircraft noise; indeed, we are convinced that more knowledge in this area is necessary, important, and of practical use. Still more countries should follow in conducting similar surveys, profiting in the process from the vast experience already gathered by several pioneering countries of which I might mention the United Kingdom, the United States, Sweden and the Netherlands.

Third, and in conclusion, I hope that some country or international organisation will follow some of the leads of this conference in the field of social sciences. I mean that there should, in my view, be further exchanges of views and experience on the aspects of planning and zoning of areas around airports; the need for this is clearly stated in the report of Committee No. 2 and reference is also made to it in the report of Committee No. 4. Though I would not expect internationally agreed rules on planning procedures to come from this I am fully convinced that a further exchange of views and experience will facilitate the work of those responsible for finding practical solutions in the next five to ten years to the problem of making the best use of land around airports and safeguarding the health and well-being of people affected by noise stemming from aircraft operations. These men need to rely on facts that are systematically produced by scientists in different fields. Our scientific methods will certainly have to be improved to become more refined yet, but time is pressing and we just cannot wait until perfection of scientific methods is attained. We have to work with the knowledge already available, but let us make it available to more people and let us foster inter-disciplinary and co-operative efforts of the kind we have experienced in the past few days.

Aircraft are flying over the political borders of our countries. Ideas and knowledge should follow the same paths.

Thank you, Mr. Chairman.

Mr. Mason: Thank you, Professor Atteslander.

Mr. Mason: Gentlemen, all of us listened with interest to Mr. Binaghi's encouraging speech, and I should once again like to thank him for his attendance at our Conference.

I should also like to thank all those who have referred so kindly to the initiative taken by Her Majesty's Government in the United Kingdom in convening this conference and for the arrangements which we made for it. When we decided last year to invite governments and international organisations to a conference on the reduction of noise and disturbance caused by civil aircraft, we did so primarily with the object of obtaining international recognition of the serious nature of this problem, and of the great social need to find a solution. Our second objective, as I said at our opening plenary session, was to provide a forum where we could pool our knowledge, our ideas and our experience in dealing with this problem.

I can confidently say—and in this I am fortified by the views which heads of delegations have expressed—that the reports we have just listened to from the chairmen of the conference's six committees show that both these objectives have been achieved in full.

But I think I can go further than this. The committees' reports have shown that there are now certain clear and definite lines of action open to us which—if vigorously pursued as they must be—could produce in the future a significant reduction of disturbance from aircraft noise at our busy international airports, and prevent the inordinate growth of disturbance elsewhere, even bearing in mind the rate at which civil air traffic is now increasing.

I would particularly like to point to the clear and unambiguous view expressed by all the committees concerned—that there can and should be some form of certification of aircraft which would ensure that future aircraft are constructed to meet detailed noise performance specifications. I think the discussions in Committee No. 1 have disclosed that technical developments have now reached the stage where it is entirely realistic to expect that such specifications would show a substantial improvement on the noise performance of present jet aircraft. This means that it now lies within our power to ensure that future jets will be substantially quieter than those operating at present.

Much hard work will of course be needed to bring this about. Many difficult problems, both technical and economic, will have to be resolved. But I can assure this conference that in the United Kingdom we intend to pursue this matter—in consultation with the governments of other aircraft manufacturing countries—as urgently and as vigorously as we can.

I need hardly add that we intend to keep in close touch with the International Civil Aviation Organization in our efforts to deal with this most important aspect of the noise problem.

I have noticed that a number of the committees' reports point—as indeed when we planned this conference we hoped they would—to other useful lines of action which should be pursued. I am particularly glad to note the exploratory work which is going on here and elsewhere as mentioned in the report of Committee No. 3, regarding the possibility of reducing noise on approach by raising the glide slope angle, and other measures.

Gentlemen, we in London, as some delegates will no doubt have noticed, are suffering increased disturbance from aircraft on their long approach to London Airport. I know that the citizens of many parts of London will most cordially welcome any substantial alleviation of noise on approach which can be brought about, of course consistent with safety, as a result of these experiments.

I do not propose to review in detail the work of all six committees, all of whom have done excellent work, but I have noticed with considerable satisfaction the progress that Committee No. 4 have been able to report in the discussion of standardisation of noise measurements. This will be of great assistance in many directions, not least in regard to the noise certification of aircraft.

Now that the conference is ending, we have to think of the next steps to be taken. I have already mentioned the action we in the United Kingdom propose to take in regard to noise certification. In many other cases it will, no doubt, be for delegates to report to their governments on the matters we have discussed together and to recommend what action, if any, should be taken domestically in regard to their own particular problems, just as we in the United Kingdom will do. But there is also scope, I am sure, for

further international action. We intend therefore, in compiling the report of the conference—which will of course be submitted in draft to heads of delegations for agreement before publication—to draw attention to the various items arising from the committees' reports which give rise to possibilities of international collaboration, and to make suggestions for appropriate further action.

Finally, while some very kind words have been said about the work done by the United Kingdom in arranging the conference, we ourselves would like to say how grateful we are to all those who have provided the many expert and stimulating papers which the committees have considered. Without these papers, and without the hard work of the committee chairmen and members, the conference could have achieved nothing. We would therefore like to express our grateful thanks to you all.

Gentlemen, I must now formally declare this conference closed. Thank you very much indeed for your attendance.

Reports of the Conference Committees**COMMITTEE No. 1****THE DEVELOPMENT AND PRODUCTION OF QUIETER AIRCRAFT
AND ENGINES****Summary of activities**

1. In the course of the conference, the committee met on five occasions with delegates from thirteen countries and organisations and discussed eighteen papers. The papers were presented by delegates from France (four papers), United Kingdom (five papers), United States (seven papers), and the USSR (two papers).

The main themes represented by the papers were as follows:

- (i) current research programmes;
- (ii) aircraft characteristics and their effects on noise;
- (iii) powerplant characteristics and internal engine design;
- (iv) the economics of aircraft noise.

The main preoccupation of the committee has been with the matter of noise generation at source. Early on in its proceedings, the committee made a recommendation to committees 3 and 4 that a joint meeting should be held with them to discuss the subject of aircraft certification in respect of noise and the proposed joint meeting was held on the afternoon of Friday, 25th November 1966.

Current research programmes

2. In France, the United Kingdom, the United States, and the USSR, active and comprehensive research programmes and studies are going on. In the engine field, the main emphasis is on means of reducing the internally generated noise from fans, compressors and turbines as representing the major problem for future subsonic engines, but particular aspects of jet noise are receiving a good deal of attention, especially in connection with engines for supersonic transports.

An effect, only recently identified, concerns the inter-action between engine noise and the vortices shed from aircraft wings in flight and a programme of research on this effect is being planned in the United Kingdom. This represents an example of the effect of engine installation on aircraft noise generation, a field which will require further study.

The committee wishes to re-emphasise the importance of continuing research on aircraft noise and maintaining co-operation between the countries concerned.

Possible improvements in engine and aircraft technology

3. The papers presented to us indicate that in the field of powerplant design there are a number of techniques under investigation and development which hold out prospects of noise reduction at the source. The trend to higher by-pass ratios for subsonic aircraft is already reducing the amount of noise from the propulsive jet. With engines of this type the main noise

source is the fan and emission from this can be limited by such measures as reduction of tip speed, adjustment of spacing of blade rows, choice of numbers of stationary and moving blades and by the use of sound absorbent linings. Another characteristic of the fan engine is the fact that the discrete frequencies generated by the fan, which can be influenced by design, make the quality of the noise increasingly important from the subjective point of view. In the field of aircraft design the scope for noise reduction is less obvious but there may be some further benefit to be derived from the known technique of moderating noise under the climb path by installing more thrust to achieve a higher initial rate of climb and by power reduction after the initial climb. Aircraft could also be designed to make possible a steeper angle of descent at lower levels of thrust if this is operationally acceptable so as to reduce noise levels under the approach path.

Economic penalties

4. But with increase in aircraft size some of these techniques will now be used to avoid the increase in noise level which would normally accompany this trend. Furthermore the design changes aimed at noise reduction are likely to involve some penalties in operating costs. The magnitude of the penalty for a given noise reduction was considered in one of the papers presented to us, but it cannot yet be assessed with certainty. What is certain is that in the competitive world of air transport an individual operator cannot afford to pay any significant penalty in quieter aircraft unless his competitors do the same. For this reason there is general support in committee No. 1 for the view that, in order to make worthwhile progress, it will be necessary by a process of certification of new aircraft to ensure that these conform to improved noise standards. Certification of aircraft for noise characteristics would also have the advantage of providing realistic goals for the engine and aircraft manufacturers and would make possible more reliable predictions of community noise exposures. What the extent of the improvement in noise characteristics should be, or within what time scale it might be realised, are questions that now need to be resolved. But some of the papers presented to us indicate that worthwhile improvements should be possible without excessive economic penalties.

Reservations

5. There are however three reservations which the committee wishes to make. The first concerns supersonic transport aircraft; these require very large engine powers and cannot use the low exhaust velocities appropriate to subsonic aircraft. In spite of certain compensating advantages such as variable powerplant geometry and a very high rate of climb it should be recognised that these aircraft present a special problem especially as regards lateral noise at take-off. The second concerns existing aircraft, the substantial improvement of which is bound to be more difficult than in the case of new designs and which is bound to introduce economic penalties on a greater and perhaps prohibitive scale. The third reservation is that acceptance of the principle of bringing about a reduction of aircraft noise at the source by a process of certification must not lead to a failure to exploit other possible approaches. It is suggested that these other approaches should be vigorously pursued at the same time, as being equally important to the solution of the overall problem.

CONTROL OF NOISE BY THE SITING OF AERODROMES, PLANNING THEIR LAYOUT AND LIMITING RESIDENTIAL DEVELOPMENT NEARBY

Introduction

1. With the object of defining the problems raised, and in order to relate the noise abatement methods considered by Committee No. 2 to other methods of noise abatement, the committee has made the following general observations.

2. The possible methods of reducing noise and disturbance from aircraft can be derived from the fact that the noise and disturbance caused generally depend on the noise at the source, the distance from the source of the noise, the frequency of noise exposure, the time of day or night when the noise exposure occurs, and the extent to which the free spread of the noise is interfered with. (Other factors, such as varying meteorological conditions and possibly to some extent background noise may be of importance in assessing the disturbance caused by aircraft noise, but do not appear to be directly correlated with any useful noise abatement methods.)

3. The purpose of the noise abatement methods considered by Committee No. 2 is to secure distance between airports and their normal associated activities on the one hand, and residential and any other noise-sensitive areas on the other.

4. Other methods which may be used as alternatives, or to supplement these methods, are:

- (a) reduction of noise at source, i.e. by the production and use of quieter aircraft (this has been considered by Committee No. 1);
- (b) reduction of noise from engines when operated for maintenance or testing on the ground (this has been considered by Committee No. 6);
- (c) operational noise abatement procedures, which may affect the noise at source and/or the distance from the source (these have been considered by Committee No. 3);
- (d) restrictions on operations, such as limiting the number of movements and/or the period when operations are permitted;
- (e) the insulation of buildings (this has been considered by Committee No. 5).

5. When considering the siting of a new airport, including its provisional layout, a number of planning considerations may conflict with the aim of securing from the outset the desirable degree of displacement between the airport and its associated activities on the one hand, and on the other the areas sensitive to noise; thus there is the necessity for compromise. These conflicting factors can be:

- (a) accessibility to the population which the new airport is to serve, and to any other airports operating linked air services, in terms of time and convenience;
- (b) suitability of the terrain;

- (c) safety, including the avoidance of obstructions ;
- (d) the routing of air traffic to and from the aerodrome, including inter-action with any other nearby aerodromes ;
- (e) the environment of the site—an airport should interfere as little as possible with local industry or agriculture, or with the amenities of the area ;
- (f) proximity to centres of population, in order that the necessary labour can be available, and also for the benefit of the airport's employees ;
- (g) weather ;
- (h) interests of other users of the airspace near the proposed airport ;
- (i) the cost of building the airport, including the acquisition of the necessary land and property rights—the expected future value of the land for other uses being a factor to be considered in this connection.

6. When planning the layout of new airports, or considering the possible expansion of, or improvements to, existing airports, the following elements of airport planning may often be relevant to the objective of achieving noise abatement by the separation of the noisy activities from the noise sensitive areas:

- (a) the orientation and method of use of the runways ;
- (b) the location of landing thresholds and start of roll positions for take-off ;
- (c) the location of the aprons ;
- (d) the location of the taxiways ;
- (e) the location of maintenance areas.

Again, these factors may conflict with the objective of achieving noise abatement in the way mentioned.

7. In order to decide on the overall noise abatement plan and to enable the best compromise to be made between the use of distance, as a means of securing noise abatement, and other objectives, it is necessary to evaluate the degree of noise disturbance in terms which indicate the relationship between the total noise exposure and the human reaction to it. The committee have noted that there are available today for planning purposes four different methods of assessing total noise exposure in terms intended to express a relationship to the human reaction to the noise exposure ; namely the British Noise and Number Index System, the Composite Noise Rating System developed in the United States, the German \bar{Q} Factor System and the French Isopsophic Index System. The question of assessing the value of these systems, and of possible improvements, has been left for the consideration of Committee No. 4.

8. In order to make an estimate, for planning purposes, of the total noise exposure round an airport at a given time, it is necessary to assess the relevant factors of noise exposure, as indicated in paragraph 2 above, at that time. If the planning authorities wish to make such an estimate for the future, the chief difficulty lies in predicting these factors.

9. To the extent that the objectives of noise abatement are achieved when the construction, expansion, or modification of the airport concerned is

first completed, there is the further problem of ensuring that, as time progresses, non-compatible land uses do not become established nearer the airport. Where the areas surrounding the airport are in themselves suitable to be used for purposes which are incompatible with the existence of the airport, any effective planning of this kind must be supplemented by the necessary means of ensuring continuing control over the use of the land, to the extent needed to ensure that the original plan is not vitiated.

10. Where the existing situation round an airport is already one which presents noise problems, the employment of land use planning as a means of alleviating the disturbance implies changing the kind of activity in the sensitive areas so as to achieve the use of this land by some less sensitive kind of activity. Again, to prevent—if possible—the noise problems from getting worse as a result of the establishment of further non-compatible uses near the airport, the tools mentioned in paragraph 9 above must be to hand.

11. Comprehensive planning which takes into account the possibility of achieving noise abatement by securing an adequate distance between the noisy activities associated with the airport and the areas sensitive to noise also involves an evaluation of the associated economic factors, such as:

- (a) the cost of restricting the use of the land—the expected future value of the land for non-compatible uses is a factor to be considered in this connection;
- (b) the relative cost of alternative noise abatement methods, if any;
- (c) the possibility of reducing cost by additional noise abatement methods, if any;
- (d) the cost of removing any conflicting planning factors;
- (e) the allocation of costs to the different interests involved.

In practice, the planning authorities concerned will probably frequently have to consider the reduction of costs by reducing the proposed degree of noise abatement, where this is possible without raising legal difficulties, or imposing a totally unacceptable degree of disturbance on those concerned. The problems referred to in this paragraph are considered in more detail later in this report, but it can be stated at this point that complete planning in this way appears generally to be impossible with the knowledge of the factors involved, and the methods available, at the present time. On the other hand, it is considered important that the economic factors involved should be taken into account as far as possible in every case which the planning authorities concerned have to consider.

Identification of noise sensitive areas round airports

12. The first requirement, for effective land use planning round airports, is to identify the areas which will be subject to noise disturbance. In view of the continuing growth of civil aviation, and the fact that satisfactory land use planning must be conducted on a reasonably long term basis where possible, this has, especially in planning new airports, to be done by reference to the future. Reference has already been made in the introductory section above to the various methods available, and also to the problems of prediction involved in studies of this kind. Because of the

problems of prediction, it has to be recognised that assessments of this character are liable to very serious error; but, in the committee's view, this does not mean that the attempt should not be made.

13. Those concerned with land use planning round airports have no choice but to seek guidance from such methods for evaluation of noise exposure as are available. Therefore, for planning purposes, it would be of considerable immediate value to have some information about the correlation (or lack of correlation) between the various systems of measuring noise exposure currently available (mentioned under paragraph 7 above). This committee has, during the conference, communicated this opinion to Committee No. 4.

14. A major problem with regard to the prediction of future noise exposure round airports consists of predicting the noise characteristics of future aircraft. Lacking more precise estimates, those concerned with planning have to rely on the assumption that the noise characteristics of new aircraft will be no worse than those of present-day aircraft, in the hope that this is proved to be a correct, and not over-optimistic, assumption. In view of the fact that planning of the type which is the concern of Committee No. 2 is frequently barely adequate because of the practical limitations to it which exist, an increase in the noisiness of aircraft will tend to make plans based on the above assumption misleading or even useless. The control of the noise characteristics of future aircraft by means of certification will make planning action easier, with regard to the degree of certainty with which it can be done, since certification should ultimately make more reliable the prediction of the noise characteristics of future aircraft. This improvement in the ability to predict the likely noise disturbance round airports would be an advantage additional to the absolute advantage to be secured by the general introduction of methods of certification aimed at ensuring the production of quieter aircraft. This committee has, during the conference, communicated this opinion to Committee No. 1.

15. When attempting to assess the future noise disturbance round airports, it is necessary to estimate the volume and type of traffic at the date or dates in question. In some instances, such assessments have been based on the estimated ultimate capacity of the airport, which in turn involves making predictions relating to a number of factors, such as:

- (a) The final state of development of the airport (number of runways etc.);
- (b) The sustainable air traffic control capacity of the airport;
- (c) The various types of traffic which will use the airport at this stage.

Estimates based on the ultimate capacity of the airport are, of course, only realistic if it is anticipated that the ultimate capacity will be achieved within a period which is sufficiently short to make predictions with a reasonable degree of certainty. An alternative approach in planning is to seek to establish the extent to which the traffic at the airport can increase or evolve without leading to an unacceptable amount of disturbance.

16. In practice the planning authorities will frequently have to make compromises with respect to alternative proposals for noise abatement, conflicting planning factors or costs imposed by noise abatement. To permit a compromise

judgment in these cases, it is frequently desirable to be able to distinguish between different degrees of disturbance in a more refined way than simply to say whether disturbance is one side or the other of the absolute limit of tolerability. This committee has, during the conference, communicated this opinion to Committee No. 4.

17. In a number of countries assessments, of the kind dealt with here, have already been carried out or are contemplated, the following having been reported to the committee by delegates:

- (a) Detailed studies of the anticipated noise disturbance around some French airports, among them the new airport Paris-Nord, have been carried out by the French authorities using the Isopsophic Index System, to form the basis of land use zoning in the vicinity ;
- (b) In connection with the selection of a site for the third London airport, maps showing Noise and Number Index contours for various stages of the airport's development have been prepared by the British authorities in relation to the proposed site at Stansted and alternative sites ;
- (c) A study has been commissioned in the USA under which noise contours, based on the PNdB concept, for the major jet airports will be drawn to form the starting point of a systems study of the noise problem, based on an evaluation of the disturbance caused by the noise exposure.
- (d) In Germany, the \bar{Q} Factor System has been used as a basis for assessing the disturbance round certain military airports.
- (e) In a number of countries not mentioned above, available noise evaluation systems have been used to obtain possible guidance for planning purposes, although it is realised that the adoption of these methods in places other than those where the social survey work supporting them was carried out is liable to error.

Accessibility to airports and its implications

18. Given the desirability that new airports should, in general, be sited in areas which are not heavily populated, the solution from a noise abatement point of view often appears at first sight to be to locate them at a substantial distance from the population they are intended to serve. In the absence of some special means of fast and convenient transport there are, however, obvious limiting factors to this approach, unless the large amount of additional money and resources involved can be found to provide the transport system required. If, of course, this transport system can serve a wider need than just that of the airport, the cost is not correctly debited exclusively to the airport. Thus, co-ordination of surface transport planning with the planning of new airport sites may increase the scope for action on the lines described in this paragraph.

Practical implications of the assessment of noise exposure round an airport

19. Having established, to the extent that present techniques of prediction and evaluation permit, the likely noise exposure round airports, it is necessary to consider what action can and should be taken in the light of this information. This action will vary according to many factors, concerned with

the possibility of changing the extent and shape of the noise zones by means of noise reduction which are not the concern of this committee, the degree of development already in existence in the noisy areas, the nature of national and other legislation concerned with the control of land use and the costs involved.

20. It seems clear that, in considering what action, if any, should be attempted, in the sphere of land use control, as a means of noise abatement, the action taken is best concentrated in the areas in which there can be no doubt that a serious noise problem exists or will arise. In areas where the noise problem is assessed to be likely to be less severe, there may be some grounds for acting with more caution, because of the inevitable uncertainty of the noise predictions involved, and because, in the less sensitive areas, a smaller proportion of the population are likely to be sensitive to noise to such a degree that serious inconvenience will occur.

21. Where effective land use control implies the need to *alter established land uses to achieve less noise sensitive uses*, in every case reported to the committee there are very narrow limits to what can be achieved, both from a legal point of view and from an economic and social angle.

- (a) A situation of this kind is reported to exist in a large number of cases relating to important international airports already confronted with serious noise problems.
- (b) As a possible long term solution there may, according to the circumstances, be a possibility that land at present used for purposes which are incompatible with the noise could be earmarked for subsequent redevelopment for a compatible use, and that this could be enforced gradually. Some delegates have expressed the view that steps on these lines are not a practical possibility in their countries, mainly for economic and social reasons, but other delegates do not necessarily rule out action of this type.
- (c) As an immediate solution, the legal possibilities are in most cases limited to acquisition of the property. This may, of course, be considered necessary and possible in extreme cases, but economic, social and legal considerations are very likely to make such action impossible on a large scale. It should be added that the general legal concept of equality of treatment, which applies in most countries, can usually be expected to lead to very wide consequences from any action of this kind, apart from the obviously extreme cases. In addition, legal provisions permitting the expropriation of property, solely on the basis of aircraft noise disturbance, do not exist in most countries.

22. Control of land use with the object of *preserving existing compatible land uses and enforcing compatible development in the future* is, according to the information given to the committee, a much more hopeful means of achieving noise abatement, even though quite severe legal, economic and social limitations arise.

- (a) The committee do not consider it possible, on the basis of the information received, and in the short time available, to produce a properly balanced statement of a comparative nature of the main characteristics of the different national laws relating to this question.

Several delegates have, however, expressed their interest in obtaining more detailed information of this kind, even though it obviously cannot be put to any immediate use. The very great practical importance of the legal issues in this field of noise abatement, combined with the difficulty from the legislative point of view of balancing the conflicting interests involved, and of creating effective means of control of land use within the limits that this conflict gives rise to, are thought to make valuable an exchange of information about how these problems are dealt with in different countries. It is, however, generally agreed that it would not be appropriate to suggest here any definite arrangements for these purposes.

- (b) It can be stated that the minimum possibility of action which is reported to be common for most of the countries represented is to enforce, without compensation, control of land use to meet an identifiable public need, which is not inconsistent with established land uses and does not conflict with the possibilities of economic land use. The different uses which it is possible to enforce in this way are not the same in all the countries represented on the committee, but in many countries restriction to industrial and agricultural use can be achieved, and this would seem to be of great practical value from a noise abatement point of view in many instances.
- (c) The extent to which noise abatement can form a legally valid reason for control of land use differs between the countries represented. In countries where this cannot be done, the scope of action is therefore limited to whatever can be achieved on grounds other than noise abatement. A legal situation of this kind clearly places substantial limits on the possibilities of effective action by means of controlling the use of land.
- (d) The extent to which private economic interests can be interfered with by means of land use control, without giving rise to a claim for compensation, is reported to differ between the countries represented. This question is, of course, of great practical consequence when considering the possibilities of land use control as a means of noise abatement, but the legal issues involved are so deeply rooted in constitutional law and legal traditions that it would not be appropriate to pursue this aspect of the matter further. However, even when restriction of land use gives rise to claims for compensation, the amount of such claims may be far smaller than the costs involved in other types of action, such as acquisition of property rights.
- (e) Apart from, perhaps, a few local exceptions, the committee have not been informed of any cases of legislation in which special legal restrictions are associated with defined noise zones round airports. The German delegation has however reported that a draft law was laid before the Federal German Parliament making provision for the establishment of defined noise zones round airports, in which various restrictions on development would be imposed; the law in its present form has not, however, been passed. It would, in the form presented, have involved prohibitively large sums in compensation.

- (f) To the extent that sound insulation of buildings provides a satisfactory means of overcoming the aircraft noise problem, the ability to use powers of land use control to require the incorporation of sound insulation in new buildings erected in noise sensitive zones may provide a more economic solution than preventing the construction of the buildings altogether. Action on these lines is already being taken round Heathrow Airport.

23. Noise exposure assessments may sometimes lead to the conclusion that the future noise problems of existing airports are so severe, and that the practical scope of action on the lines with which Committee No. 2 is concerned is so limited, as to call for the closure of the airport and its replacement on a new site. If noise considerations are the only reason for closure, such a conclusion must however be treated with considerable caution, as it depends on assumptions about the future which are necessarily to a greater or lesser extent speculative, and on the possibilities of action on lines which are not the concern of this committee. Moreover, removal of a major airport to another site will involve the airport owner and the airlines in very considerable expenditure. In addition, such a removal can cause considerable disruption of the local economy round the airport. The committee were informed of a particular case where the bulk of the operations of an airport were transferred to another location—for noise and other reasons—with the result that complaints about noise were replaced by complaints about loss of employment.

Co-ordination between civil aviation and other planning authorities

24. Since the matters dealt with by Committee No. 2 are essentially concerned with the relationship between the airport and its environment, effective action in this sphere demands the fullest exchange of information about future plans, and co-ordination of action, between those who are concerned with civil aviation planning, and those concerned at all levels with planning the development of the surrounding land, and with implementing such plans.

Assessment and allocation of costs of reducing aircraft noise

25. The economic aspects of aircraft noise reduction present extremely complex problems. From their discussions, however, the committee evolved the following broad economic concepts which are believed to be constructive:

- (a) Aircraft noise reduction costs break down into three distinct sub-elements: the cost of aircraft design or modification, the cost of aircraft path conversion and the ground environment cost, which includes costs such as those incurred in respect of muffling engines on the ground, as well as costs arising from action taken to ensure land use compatibility. Each possesses differing characteristics, thus requiring separate recognition. Ground environment costs arise from costs incurred from modifications—in the broadest sense—to ground environment. Economic responsibility for these costs could reasonably be borne, to a greater or lesser degree, by those whom the airport benefits—the aircraft manufacturer and operator, the airport operator, central and local Governments, the passenger, the shipper, industry, commerce and the citizens of the community involved. The solution requires acute focus upon the degree to which the ground

environment 'cure' is to be pursued at any given airport location. Noise reduction should be objectively pursued within a realm of economic feasibility in the absence of other overriding factors.

- (b) The systems analyses approach utilising computer techniques and mathematical models appears to be a feasible and desirable method for identifying alternative ground environment actions and their related costs. This view reflects acceptance of the data processing state of the art as benefiting the decision making process. However, pursuance of the mathematical model process to an optimum mix of a least cost solution is intended as an aid, and not a substitute, for a judgmental decision.
- (c) In determining allocation principles for ground environment noise reduction costs, a uniformly lacking element of knowledge is the degree to which a community gains economic benefits from an airport's existence. Governments might wish to consider whether effort should be directed towards the development of methodology which discloses this factor.
- (d) Land use compatibility should not be viewed as a panacea to the aircraft noise problem. There are definite physical limits upon land availability, as well as upon the ability to utilise land for purposes which are noise compatible. These often prohibit decisions about land conversion based upon economic costs alone.
- (e) Comprehensive area planning, which embraces area economic planning, is viewed as a useful contribution to the solution of the aircraft noise problem. Such action will ensure, so far as is practicable, compatible development of new airport undertakings, and in many instances has some application at existing airports. In both cases it would help in the allocation of development costs, including those relating to ground environment modifications required for noise abatement.

Scope for action

26. The discussions of the committee have shown that action on the lines with which it was concerned can be of definite, but in some cases limited, use particularly for new airports or those which are at an early stage of development. Much greater difficulties are likely to arise, however, at existing airports of a major character where the volume of traffic is large and where the environment is already heavily developed.

Continuing international exchange of information

27. The exchange of information between delegates on Committee No. 2 has shown that great benefit can be derived from a sharing of knowledge on this aspect of noise abatement, which has so many complex and inter-related aspects. While there does not appear to be scope for international standardisation in this field, in view of the widely differing circumstances in different countries, it is considered that some machinery to permit exchange of information on a continuing basis would be very useful. The committee consider that the International Civil Aviation Organization might be able to play a useful role on some aspects of this question.

OPERATIONAL NOISE ABATEMENT PROCEDURES DESIGNED TO LIMIT THE AMOUNT OF DISTURBANCE CAUSED BY AIRCRAFT TAKING OFF, IN FLIGHT, OR LANDING

1. The committee, under the chairmanship of Mr. C. A. F. Falkenhagen, met on nine occasions with representatives from seventeen countries and five international organisations attending.

2. A total of fourteen papers on the subject dealt with by the committee were presented. The committee discussed these papers but did not set out to reach decisions or conclude binding agreements. The committee was of the opinion that operational procedures had made a significant contribution to noise abatement. They felt that these procedures would continue to play a part in the reduction of noise nuisance and that further studies were valuable from the point of view of making this contribution more effective. However it was felt that with the present aircraft and ground and airborne equipment no very significant further reduction in noise by way of operational procedures was likely to occur since these had in many cases, reached the limits possible without degradation of safety. The committee considered that it was in the field of quieter aircraft and compatible land usage and runway siting, especially at new airports, that the biggest contribution would have to be made. It was agreed that when originating operational noise abatement procedures the views of all interested parties such as the airport authorities, the airlines, air traffic control and pilots' organisations should be taken into account and that at all times safety should be the paramount factor.

3. It was agreed that the use of a preferential runway system was justified as a noise abatement procedure, i.e. the use of a runway for noise abatement reasons relating to take off or approach when another runway was available which would give less adverse wind conditions. The committee noted however that this procedure could result in some degradation in safety in certain circumstances both during take off and landing. Among these circumstances were the following. Crosswind components which if too high caused control difficulties, especially for swept wing aircraft. Icy, wet or damp runways that caused hydroplaning or other braking or control difficulties. Wind shear effect under tailwind conditions which could increase the rate of descent and affect the landing distance due to floating. Tailwind components also increased the difficulties on contaminated runways. The criteria for continuing to use the noise abatement runway should therefore take into account all these points but as a general rule the runway should be dry and of adequate dimensions. The opinion of pilots' organisations represented on the committee was that the criteria for selecting the preferential noise abatement runway should be a dry runway, maximum cross wind component 10 knots and no tail wind. At some aerodromes the criteria were a 15 knot cross wind and 5 knot tailwind component where justified by the runway dimensions and surface conditions. The possibility of using the runway coefficient of friction as a factor in the use of preferential runways was considered and the committee was told that the Scandinavian airlines use the reported figure when calculating the maximum allowable crosswind component for take off or

landing (as distinct from preferential runway selection). However it was not thought by the committee that at present aerodrome authorities could use this method when selecting the runway to be used since the degree of effect of a runway's coefficient of friction, when it could be accurately measured, would vary from aircraft to aircraft and operator to operator. However as better and more uniform procedures for measuring coefficient of friction on runways were developed and a more uniform application of this value agreed by operators it could become one of the parameters affecting the selection of a preferential runway.

4. The committee next considered the take off case and were of the opinion that no further complications to the pilot's task could be added to those already caused by existing procedures without an adverse effect on safety. Pilots required simple and standardised procedures which allowed sufficient speed and height to be acquired before power cut back to allow adequate margins for contingencies such as power failures, collision avoidance manoeuvring, instrument failure, turbulence etc. This would certainly be not less than $V_2 + 10$ and many delegates were of the opinion that it should be more. Pitch attitude required on the climb was important and a figure of the order of 15 degrees was considered as the maximum for most aircraft. Some type of computed pitch command which would assist the pilot in maintaining an optimum climb profile would be of benefit for the safer operation of noise abatement procedures. The angle of bank in turns should not need to be excessive for the type of aircraft concerned.

5. The point at which a power cut back should be made was the subject of many differing views varying from an absolute minimum of 600 feet to about 1,500 feet. The Federal Aviation Agency of the United States informed the committee of experiments in progress at Washington National Airport with a standard take off flight profile for use by all jet aircraft. This trial application consisted of a full power climb to 1,500 feet followed by a power cut back to produce thereafter a reduced gradient climb up to an altitude of 3,000 feet at which point normal en route climb power was applied. It was not intended that there would be a noise monitoring element with this procedure but that compliance would be checked by in flight inspections. Many delegates favoured a standard procedure as being good for safety and also for producing more uniform results. Many other delegates, however, felt that the population distribution round airports could not be ignored and a standard procedure such as this would not necessarily produce the best result where the noise sensitive area is close to the runway end. It was also felt that not enough evidence of noise values produced by this technique as compared with others was available to enable a sound judgment to be made. The committee recommended that comparative data for various take off techniques relating to general classes of aircraft and engines should be obtained.

6. The committee considered the effects of monitoring systems based on a point system and on an area system on operational noise abatement procedures. They noted that an area system allowed a more flexible use of the operational procedures and that the point system, which required a specified noise limit to be met at a specified point, tended to produce more noise beyond that point. In the operational sense the committee felt that

the flexibility allowed by the area system was an advantage but in the noise abatement sense considered the choice was a matter outside their competence and one which no doubt would be influenced by the population distribution at a particular locality.

7. On the question of minimum noise routes the committee felt itself unable to say whether in principle, if there was an even distribution of population under the departure areas, it was better to concentrate or disperse the flight paths as this was a sociological question. It recognised however that if concentration was desirable on noise grounds this tended to reduce ATC flexibility and movement rate. Adherence to minimum noise routes was dependent on the navigational aids available. In general these aids, although quite adequate for ATC purposes, did not allow exact track keeping. A view was expressed that pictorial presentation on the flight deck was an aid to accurate track keeping which allowed noise sensitive areas to be depicted and kept pilot work load to a minimum. The delegate of the Federal Republic of Germany gave indications of typical scatter about a track derived from measurements.

8. The committee discussed the height above which noise abatement procedures need no longer apply. The situation was confused in as much as this height was based for the take off phase, in some cases on the height at which normal power settings could be applied and in others on the height at which minimum noise routes need no longer be followed after take off. The committee also noted that even when an aircraft had resumed normal operation it was still the cause of many complaints and any height selected would be dependent upon the type of aircraft, the area overflown and the noise value selected. Much of this was outside the committee's terms of reference but the need for a uniform approach to the problem was recognised and it therefore recommended that the matter should be further investigated with a view to producing standard procedures for determining the height above which normal aircraft operation was permissible.

9. In the approach phase the committee was again unable to decide whether tracks from the holding stacks to the point at which the intended runway centre line was reached should be dispersed or concentrated. The latter was possible but it was recognised that the use of only one track would adversely affect movement rates. Most delegates were of the opinion that for an instrument approach an altitude of between 1,500 feet and 2,000 feet was the lowest altitude for joining the glide path and a minimum length of final approach was 6 to 8 nautical miles. This was necessary to enable the aircraft to stabilise on the approach and in some instances dictated by the use of automatic approach aids. Shorter approaches for large high performance aircraft under 'visual meteorological conditions' were not considered conducive to safety or in some cases to noise abatement since the aircraft was necessarily at a lower altitude and coarse throttle movements often necessary but here again population distribution or land use would have an important bearing.

10. The committee discussed further aspects of the take-off and climb out case and were informed by the UK Air Registration Board, that as a result of their investigation into noise abatement techniques practised on UK registered aircraft the Board have now published requirements on this

subject. Most British jet aircraft flight manuals contain advice on the techniques which can be safely used and all further types will have to comply with the take off climb techniques specified in Issue 8 of *British Civil Airworthiness Requirements**, Chapter D 2-8, para. 3.3.

10.1. These requirements embrace the concept of a smooth transition following take-off to a stabilised climb speed V_4 at a height not greater than 400 feet. The V_4 speed shall not be less than $1.2 \times$ minimum control speed or $1.3 \times$ stalling speed, and there must be a margin of 15 knots below the flap limiting speeds.

10.2. No power reductions may be made before 500 feet, and the gradient of climb following this must not be less than 2 per cent. Furthermore the noise abatement profile must exceed the net flight path with one engine inoperative by 1 per cent and 0.8 per cent for four and twin engined aircraft respectively.

10.3. No specific limitation has been placed on deck angle but there must be a margin of 5° between the maximum angle which is likely to be achieved in operation and the limit to which the main pitch attitude indicators will function with acceptable accuracy.

10.4. The aircraft must exhibit satisfactory speed stability and spiral divergence characteristics for the conditions selected, together with adequate lateral and directional control.

10.5. The techniques which are established within the framework of these requirements shall be valid for the lowest weather minima for which take-off is envisaged. It is not intended to produce techniques from which no deviations may be made but rather to produce safe limits within which the aircraft may be safely operated.

11. The committee generally agreed that turns should not be initiated below 500 feet or concurrently with power reduction although it was recognised that in a few special cases, and not always for noise abatement reasons, a lower height could be used, or provided sufficient margins of speed and height were available power reduction and a turn could take place together. It was also the committee's opinion that a turn should be commenced by reference to altitude rather than time.

12. The committee heard with interest of work being undertaken in the United States in relation to approaches on a 6 degree glide slope and on a two segment glide slope with the outer portion at 6 degrees and the inner portion at 3 degrees. Research that is being conducted by the NASA has involved various types of aircraft being flown to conform to both the 6 degree and two segment glide angles by reference to instruments down to 200 feet followed by a flare, with the safety pilot maintaining visual reference. These studies indicate that the 6 degree approach can reduce the noise from current jet transports by 13dB (SPL) but instrumentation displays and power settings are causing some difficulty. Further experimentation is being conducted by the FAA which involves a two segment ILS approach. Glide slopes of 5.5° and 2.5° have been installed at Dulles airport for use in weather conditions of at least 3,500 feet ceiling and 3 miles visibility. There is also an associated DME facility. A 10 dB (SPL) noise

**British Civil Airworthiness Requirements* (Air Registration Board).

reduction has been achieved. Pilot and airline representation in the committee expressed doubts about the high rates of descent if a 6 degree glide path angle were used and on the short visual exposure time and increased risk of heavy landings. With the two segment approach fears were expressed that the transition from 6 degrees to 3 degrees would cause large power changes and excessive noise. The need for a sufficient length of 3 degrees segment to allow aircraft stabilisation after the transition was noted and the view expressed that this should be five or more miles from touch down, although present US studies used 3 miles.

13. The possibility of joining the glide path from above was briefly discussed. It was thought that this was generally acceptable provided distance out could be determined by some suitable means such as radar or a suitable flight deck presentation and provided that the problem of splits in the ILS glide slope beam could be overcome and interception of the glide slope was made at a suitable angle and distance out. It was also noted that not all present auto couple systems could join the glide slope from above.

14. It was generally agreed that to deliberately displace a threshold solely for noise abatement would be very expensive in terms of changes needed in the approach lighting and in the siting of the ILS glide slope transmitter and the reduction in noise not generally commensurate with the complications and expense. It was considered worthwhile however, to retain the original threshold when possible where runways were lengthened and approach light problems could be overcome if the displacement was not more than 1,000 feet.

15. There was some discussion on the possible need for research and development on ground and airborne equipment to provide guidance for curved approach paths, when two parallel runways are used independently for take off and landing. With a suitably designed curved approach path altitude separation between converging traffic streams would not be needed and therefore aircraft could generally be kept higher so assisting noise abatement. In any such development it was emphasised that the performance of airborne equipment such as gyros would need to be considered.

16. In considering approaches with automatic thrust control the committee noted that because this equipment had to be sensitive to small decrease in aircraft speed coarse throttle adjustments could result in increased noise and unless this were overcome it could nullify the noise reduction achieved on a two segment approach. The point at which undercarriage and flaps were lowered could be selected to help this problem as could some excess speed on the approach.

17. The committee listened with interest to the presentation of a paper which set out the need to determine the cost per increment of noise reduction for all types of airports, aircraft fleets and population distributions. Of particular interest was the proposal to use a launching device to accelerate aircraft to 375 knots to allow height to be attained before application of climb power. The committee could foresee many difficulties but commended the author on a most comprehensive paper and his answers provided to the many queries.

METHODS OF SPECIFYING MAXIMUM PERMISSIBLE NOISE
LEVELS, HOW SUCH LEVELS SHOULD BE DETERMINED, AND
METHODS OF ASSESSING COMPLIANCE

1. **Methods of specifying maximum permissible noise levels**

1.1 The committee had before it a number of papers dealing with various aspects of the measurement and assessment of the noise of aircraft, and received an announcement from the ISO delegate of the publication on 15th November, 1966, of ISO Recommendation 507, *Procedure for describing aircraft noise around an Airport*. This specifies that the results be computed as Perceived Noise Level in decibels (PNdB) for which it gives a definitive method of calculation from octave-band analysis of the noise.

1.2 **Primary measurements.** The consensus of the committee was that, for aircraft noise, Perceived Noise Level is the best available predictor of the subjective attribute of "noisiness", and that where the highest accuracy is needed, e.g. in specifications which may be the subject of guarantee between the manufacturer and the airline, it should be used. The manner of computation defined in ISO 507, is applicable only to continuous broad-band noise, and it is recognised that some modifications will be needed to take account of such factors as duration and the presence of pronounced pure tone components. The committee expressed the view that ISO should be asked to proceed to specify these modifications.

1.3 **Monitoring.** Since airlines might find difficulty with noise specifications in terms of Perceived Noise Level, and noise limits (which might be imposed at airports) in terms of some other unit, the committee thought that such limits should be prescribed in terms of Perceived Noise Level. It recognised that monitoring procedures for checking compliance with such limits might need to use direct reading instruments. The instrument developed in Norway was noted, but it was considered that instruments reading a weighted sound pressure level (N or A appropriately corrected) would give a sufficiently good approximation to Perceived Noise Level for this purpose.

1.4 **Total Noise Exposure.** At the present time five methods of assessing total noise exposure, taking account of the noises of individual operations and of their number and duration, have been put forward in different countries—USA, UK, France, the Federal Republic of Germany together with Austria and Switzerland, and the Netherlands. The methods vary somewhat in the manner in which noise and number and duration are compounded, but the resulting differences are not large compared with the variability of human response to one and the same noise. A compromise proposal has been formulated by ISO and is at present under consideration by its member bodies. A further difference is that the methods of USA, UK and France express the noise in terms of Perceived Noise Level while the others use dBA. The argument put forward by those who favour dBA is that it gives an equivalent level directly comparable with traffic or industrial noise, which ISO describes in dBA. The different measures of total exposure are, moreover, designed to be used for different purposes—assessment of probable public reaction (USA), assessment of average annoyance (UK) and for

surveillance of noise climate, zoning and planning purposes in the other countries. Since these are domestic matters, the committee was of the opinion that the need for immediate agreement in this field is not so urgent. The outcome of the ISO proposal might well be awaited and it might be that further testing against the results of social surveys was desirable. In this connection, attention was drawn to the need for comparable procedures to be used in social surveys in different countries and to the programme prepared by OECD for such surveys, which it was understood would be generally available. The committee expressed the view that member countries of OECD undertaking social surveys should co-operate through that organisation.

2. Control of aircraft noise

2.1 In order to place the subject allotted to it in perspective, the committee gave some consideration to the general problem of the control of aircraft noise. It recognised that :

- (a) disturbance from aircraft noise is serious now in the vicinity of a number of airports, although at others the situation does not yet cause concern ;
- (b) apart from favourable changes in land utilisation near airports and in the noise performance of aircraft, the possibilities for reducing disturbance at the present time seemed to have been largely exhausted, but the findings of Committee 3 on this matter are awaited.

2.2 The committee recognised further that realisation of the following possibilities would make the disturbance even more serious where it now exists and would create disturbance in the neighbourhood of airports that are now disturbance-free :

- (a) traffic growth
- (b) increase in the noise produced by aircraft
- (c) uncontrolled development in the neighbourhood of airports.

The committee accepted (a) as healthy and desirable but did not accept the inevitability of (b) or (c). On the contrary, there were hopes that, in due course, aircraft might be made less noisy and the surroundings of airports less noise-sensitive.

2.3 The committee, which included delegates representing airlines, airport authorities and pilots as well as governments, agreed unanimously that, if such hopes were to be fulfilled, it was of the utmost importance, to introduce as soon as possible a system of noise certification of aircraft, including the specification of appropriate operating procedures. Not only was this necessary to ensure that future aircraft should be designed from the outset to be less noisy, and that, where at all practicable, retrofit measures might be taken, but it would provide the data on the noises to be expected in the future, which are necessary as a proper basis for land usage planning, particularly in the neighbourhood of new or expanding airports.

2.4 The system of noise certification envisaged by the committee would be analogous to that employed in the field of airworthiness. It would be based on the principle that an aircraft would be granted permission to operate only if the noise performance of that aircraft were demonstrated

to be at least as good as a specified standard. Approved flight procedures might well be associated with the noise certificate. The system could work only when the standards used by the certifying authorities in the different countries were effectively the same.

2.5 The committee appreciated that there would be many problems to solve before a practicable system could be brought into effect, but, in the time available at this conference, it was not possible to do more than identify some of these. Those mentioned in the course of discussion included :

- (a) the time scale for the application of noise certification ;
- (b) the feasibility of some degree of retrospective application ;
- (c) the setting of different standards for different categories of aircraft ;
- (d) the legal problems of particular states.

The committee thought that the national administrations principally concerned should press forward with studies of all the relevant issues, working closely with ICAO, which had a large role to play. The committee noted that aircraft noise would be considered by the Fifth Air Navigational Conference of ICAO, to be held in the autumn of 1967.

2.6 The committee went on to consider the progressively growing impact that a system of noise certification might have. Such a system could not affect the noise problems of today. In the long-term, there is the possibility that it could ultimately create the conditions in which aircraft could operate without restriction for reasons of noise abatement at airports throughout the world. In the intermediate period of uncertainty, despite any efforts which the airport authorities may make, there would remain some airports where restrictions of one sort or another (especially at night) would have to be imposed, until operating procedures and improvements to present aircraft would permit increasing freedom of operation. It might assist airlines to minimise the effect of these restrictions if information were included in flight manuals to assist in achieving a given noise performance.

2.7 The committee thought that the contribution it was in a position to make at this time concerned a standard predictor of noisiness, which appeared a primary requirement for the establishment of a noise certification scheme. As already reported (para. 1.2) it was the consensus of the committee that Perceived Noise Level as specified in ISO 507, with the modifications indicated in para. 1.2, should be used.*

2.8 Consideration would have to be given to particular points on the ground at which the noise of an aircraft, following prescribed flight procedures, should be determined. It was suggested that a point below the take-off path, a point below the landing path, and a point to the side of the runway might often be sufficient.

3. Determination of maximum permissible noise levels

3.1 There was much discussion on the basis on which the maximum permissible noise levels should be determined. Suggestions ranged from ensuring that the situation remained no worse than at present, through the

*Although certification is envisaged exclusively in terms of Perceived Noise Level, it is foreseen that detailed physical descriptions of the aircraft noise, e.g. in octave bands, will be useful for those concerned with sound insulation in buildings.

maximum reduction which the state of the art could produce, to deductions from what might be considered a not unacceptable total noise exposure at a 'typical' busy airport.

3.2 The committee appreciated that the maximum noise levels to be permitted would be a compromise for so long as aircraft noise disturbance remained a problem. Ideally such a compromise should represent an optimum taking all factors into account so that the economic and social burdens are distributed equitably. To do this would be a formidable task but one to be commended to all authorities and organisations concerned with aircraft noise. In this connection the committee noted that studies are going on in the USA resulting in a typology of busy airports of different natures so that fuller use could be made of the concept of total noise exposure. Further sociological surveys of the type recommended by OECD should also be taken into consideration.

3.3 The committee had, however, agreed unanimously on the urgency of introducing a system of noise certification (para. 2.3). In these circumstances the noise limits for such a system would probably have to be decided in the first place on the basis of a judgment as to what constituted a substantial reduction compatible with what is possible.

4. Methods of assessing compliance

4.1 Several papers on the techniques of monitoring were discussed by the committee, and it was pointed out that it is not always necessary to monitor acoustically. For example, a direct measurement of the aircraft path may check that the flight procedure required is being followed. Techniques are, in the main, a matter for local choice, but as pointed out in para. 1.3, in situations where aircraft noise limits are imposed they should be stated in terms of Perceived Noise Level, and the aircraft noise measured should be stated in the same terms, even if an approximate method of measurement is used.

5. Legal aspects of control of aircraft noise

5.1 Three papers on the legal aspects of aircraft noise control in the USA were presented and discussed. The committee noted that the legal problems in the USA were similar in some respects, and different in other respects, to those in other countries. It was common ground, however, that unsafe operations would not be permitted, and that in an emergency the requirements of safety would over-ride those of noise. The demand for an accurate evaluation of noise measurements in terms of noisiness, as a prerequisite to legislation, would, in the view of the majority of the committee, be adequately answered by the adoption of the methods set out in section 1.

APPENDIX

Liaison with other Conference Committees

1. Because of their joint interest in a system of noise certification, Committees 1 and 4 met under the Chairmanship of Mr. P. Lloyd (UK). A useful interchange of views took place which contributed to the compilation of this report.

2. Two matters connected with the assessment of noise nuisance round airports were referred to Committee 4 by Committee 2. The first concerned

the various systems for assessing total noise exposure and the comments of Committee 4 on this are given in paragraph 1.4 of this report. The second matter concerned the possibility of assessing the amount of disturbance in a more refined way than a simple dichotomy between tolerability and intolerability. The view of Committee 4 was that this was already done by the authors of the various systems of assessment of total noise exposure, but that, because of the wide variability of human response to noise, too great a refinement would be illusory.

METHODS OF INSULATING BUILDINGS NEAR AIRPORTS
AGAINST AIRCRAFT NOISE

The committee had four papers before it for discussion.

Paper no. P3 which was taken first, amounted to a summary of a comprehensive design guide to the acoustic treatment of any type of building exposed to aircraft noise of any level. But the detailed examples were confined to existing dwellings.

The approach was a textbook one, requiring the determination of the exposure noise level and the choice of an acceptable criterion of acoustic comfort within the building.

The paper examined two classes of house construction (brick or block and timber stud) and the remedial measures necessary to bring each up to one of three grades of sound insulation.

The need for mechanical ventilation in all cases was recognised, but was not described. It was assumed to consist of an extension of the existing (warm air?) heating system to an air-conditioning system, with the addition of acoustic muffling.

A range of estimated costs was given.

Paper no. P4 was a general account of sound insulation methods and principles, with a brief statement of the design steps required to arrive at the insulation values necessary in a particular case. Examples of window insulation were given.

Paper no. P2 dealt with a specific grant scheme for the improvement of noise protection of existing houses within a defined area round Heathrow Airport. The measures prescribed included the addition of a new inner window to convert the existing single window to a double one, sealing up air leaks, and the provision of sound attenuated room-ventilation units.

An acoustically controlled automatic window feasible for buildings other than dwellings in situations exposed only intermittently to noise was also described.

Paper no. P5 described in some detail the regulations in Japan relating to the sound insulation of schools and hospitals near military aerodromes.

The discussion of the papers allowed a useful exchange of views amongst members of the committee, who were drawn from a variety of backgrounds—acoustics experts, architects, engineers, administrators. It showed that, given a knowledge of how much sound insulation is required in a given building, the technical means is available to provide it. Cost and other considerations including psychological ones may, of course, affect the decision. Further research leading to improved technical means at reduced cost is needed. The major points that emerged were:

- (i) the value of the tentative approach to the sound insulation problem outlined in one of the US papers (P3). Whilst not necessarily applicable in detail in other countries, it was welcomed in broad principle;

- (ii) the need for more investigation to be undertaken into possible preferential variation of the sound insulation of constructions with the angle of incidence of the sound. This might have particular reference to noise from aircraft during maintenance, running up, and other ground operations ;
- (iii) the need for work to correlate laboratory sound insulation measurements with measurements on actual building. This is a well known need but one the committee thought worth emphasising. There is also a need for internationally acceptable standard methods of measurement on external elements of construction ;
- (iv) the UK grant scheme for sound insulating existing houses near Heathrow Airport, London was noted with interest as a pioneer effort. Technical, administrative and cost questions were discussed ;
- (v) the possibility that, with increasing noise from many sources outside buildings, building regulations might lay down standards of sound insulation for external elements of construction just as, for example, the UK building regulations do for internal party walls and floors.

The committee noted that aircraft noise affects the whole environment ; the committee has only been concerned with the protection of buildings, thus leaving out of consideration the whole range of outdoor activities. In the field that the committee has considered there is a clear need for continuing international co-operation.

METHODS OF REDUCING NOISE FROM AIRCRAFT AND ENGINES WHEN OPERATED FOR MAINTENANCE OR TESTING ON THE GROUND

Categories of noise, their effect and the need for measures of control

1. Noise from aircraft running up engines can create special concern even though it may be less than that caused by aircraft taking off and landing.

Although pure jet aircraft now predominate at major airports, the numbers of propeller driven aircraft, both turbine and piston-engined, are still sufficient to warrant consideration.

Piston-engined aircraft generally require longer running-up periods particularly in colder climates.

Thus, noise in the running-up phase may be said to be of three types:

- 1.1 jet engine compressor—a high frequency noise radiating mainly forward of the engine. Of short wave-length, it does not readily penetrate solid objects and generally dissipates itself within a comparatively short distance from source ;
 - 1.2 jet engine exhaust—a lower frequency noise with a lobe of maximum intensity for the overall sound level at an angle of about 135° from the intake. It has the typical characteristics of long wave-length sound, travelling further and not being so readily affected by physical obstructions. Additionally some noise, of mixed origin, emanates from the engine casing ;
 - 1.3 propeller noise—this noise is generally of lesser overall intensity than that of pure jets ; it emanates at right angles to the aircraft axis.
2. Persons affected by noise can be placed in three main categories :
- 2.1 those working in close proximity to an aircraft running-up. Noise is of such intensity in this location that it may become injurious to hearing ;
 - 2.2 airline or administrative personnel, working in buildings on an airport. At this location noise can interfere with work ;
 - 2.3 persons living or working outside an airport. Airlines accept that they have a responsibility in conjunction with the airport authorities to keep the nuisance caused by noise below a level at which there would be complaints. No attempt has been made to lay down a precise formula for this level.

3. The committee were unanimous in the view that measures must be taken to restrict the overall noise levels at airports, in the interests of both airport personnel and local communities.

The relative responsibilities of government/airport authorities/airlines, for complaints or claims arising from ground running noise

4. There was a general expression of opinion that this committee should not consider the question of national legislation relating to responsibility

for noise at aerodromes. The meeting in general agreed that there should be a single authority, at least at airport level, with overall responsibility for controlling excessive noise. This could most appropriately be the airport authority. Certain delegates stated that responsibility at present rests with the individual airline.

5. The authority should have the power to restrict running-up to certain portions of the airport and to ensure that airlines' running-up procedures and equipment were such that no undue nuisance was caused to nearby communities.

6. In exercising their powers the aim of airport authorities should always be to further reduce the nuisance caused by aircraft noise. Technical advances in the abatement of ground running noise should therefore always be encouraged.

7. Delegates noted that development of land outside the aerodrome might encroach on an area which, because of its earlier remoteness, had been allocated as a run-up area. Such development could lead to noise complaints. It was therefore important that steps be taken to restrict uncontrolled development.

Measures which can be taken to reduce ground running noise

8. This section is concerned solely with the running-up of engines installed in aircraft. Engines removed from aircraft for major repair or overhaul are normally provided with special sound proof test cells which present no problem.

- 8.1 Selection of appropriate run-up areas, aircraft heading etc. Run-up areas should obviously be sited in positions where disturbance to local communities would be at a minimum. Such siting should however be compatible with the efficient running of the airport.

The actual heading of an aircraft can be an important factor, having regard to prevailing wind and weather conditions.

- 8.2 Use of physical barriers or other forms of protection. Earth banks constitute a substantial physical barrier between the aircraft and areas which might be affected. They restrict high-frequency noise such as that created by propellers, but are of limited value in reducing jet exhaust low-frequency noise. Earth banks could be a cause of damage to 'T' type aircraft tails, due to the reflection of sound pressure waves.

The position of hangars, and other buildings can be used to advantage. Each case has to be studied independently.

Vegetation, trees etc. are valuable as absorbers of sound; it was remarked, however, that these were also a source of attraction to birds, a hazard that was receiving considerable attention in other spheres.

- 8.3 Use of 'hush houses', engine mufflers—static? mobile? front end?

- 8.3.1 'Hush houses'. There seems no doubt that the 'hush house', details of which are available in the German and Swedish papers is a most effective reducer of engine noise. Its

disadvantages are its cost (6,000,000 DM about £500,000) and the fact that more than one 'hush house' would need to be provided at large airports. It is conceivable that the 'hush house' could be the answer at a single operator airport in a densely populated area.

8.3.2 Mufflers. Much research has been done in a number of countries. Mufflers for the present generation of aircraft are now available at costs ranging from £10,000 to £35,000 each. They provide a noise reduction of 25-30 PNdB at 200 ft. from the engine.

8.3.3 Mobile or static. Initially it had been considered that mufflers should be mobile. However, experience has shown that there are serious practical difficulties in evolving for large civil aircraft a muffler which is easily manoeuvrable. The consensus of opinion now is that at present better results are obtained from fixed mufflers. Some delegates said they would still be interested in a mobile muffler if a satisfactory one could be produced.

8.3.4 Front-end. Experiments have been made with various types of screening. Attenuations of up to 10 dB have been achieved in the immediate vicinity, but at distances beyond 1,000 feet there was no noticeable improvement, the higher frequency noise becoming absorbed in the general pattern. Experiments with this type of muffler have now been discontinued by UK airlines.

Reduction of ground running time through the use of electronic and other devices

9. Delegates agreed that this was a worthwhile field for further research and development. BEA gave figures showing the extent to which they have reduced running-up time. BOAC and IATA stressed that curtailment of running-up time should not be achieved at the expense of safety. Interest was expressed in the use of computers to provide information which would enable run-up times to be reduced. Another important factor is the efficient planning of maintenance checks, to avoid unnecessary running-up of engines.

Restriction of hours when run-ups can be carried out

10. Delegates were of the opinion that so long as the noise problem existed, restriction of run-up at night is a justified method of reducing the nuisance, and often has to be accepted. Such restriction can seriously affect the economics of airlines, and must be as flexible as possible. Additionally there may be scope for airlines to spread schedules more evenly throughout the twenty-four hours.

Measures to reduce the effects of noise on airport personnel

11. It was recognised that this is a problem for individual airlines and airport authorities. However, it was felt that the exchange of experience in this field would be of value to all concerned. It is therefore reproduced below:

11.1 working on aprons in close proximity to aircraft. Noise is of such intensity in this location that it may be injurious to hearing and health. This is recognised by most major airlines which provide ear plugs, ear muffs and helmets and arrange the periodical medical examination of personnel exposed to such noise. There was also a suggestion that measures to protect other parts of the body against injury might be necessary in future ;

11.2. working in nearby buildings. At this location noise can interfere with work. When all has been done to site run-up areas as effectively as possible, provide mufflers and take other appropriate measures, sound-proofing of buildings would appear to be the remedy.

12. Additionally, delegates referred to the nuisance which may be caused by auxiliary power units in aircraft. In both France and Denmark the workers' Unions have complained about the noise of APU's which, they allege, have a deleterious effect on the baggage loaders. In Denmark APU's are not used. In Paris the length of time they may be run is restricted by a 'gentleman's agreement' to fifteen minutes between turn-round. In Switzerland aircraft using noisy APU's are parked away from buildings.

13. Delegates agreed, as an interim measure, that we should try to reduce APU noise ; the long term solution was the provision of fixed apron services by the Airport. No undue nuisance from these units has yet been experienced at UK or US airports.

The implications of ground running noise restriction measures on airline operations and economy

14. There are occasions when these restrictions involve an aircraft in un-productive taxiing and some loss of time ; however, the use of mufflers in normal conditions has not so far been found to have a noticeable effect on airlines' operations or economics.

15. The main impact is in the initial provision of mufflers, and the cost of sound-proofing buildings in the vicinity of run-up areas.

The feasibility of using meteorological data

16. Delegates were interested that meteorological conditions could affect the transmission and intensity of noise to the degree demonstrated in the paper submitted and amplified by the UK Meteorological Office delegate.

17. They concluded, however, that it was unlikely that any practical use could be made of any noise prediction service at this stage because of the economic penalty that would be incurred by restricting maintenance and aircraft movements during periods of 'above average' noise conditions.

The practicability of defining noise criteria

18. After much discussion delegates agreed that it would be difficult to attempt in this committee to establish measurable disturbance criteria, to which the level of engine noise could be related. Furthermore, such criteria must differ from one aerodrome to another, and also from one period of time to the next.

19. Delegates noted that in the UK it had been found that in the case of ground running aircraft, if noise levels of 85 PNdB by day, and 75 PNdB by night, were not exceeded in the environs of Heathrow (London) Airport, few complaints were received. These levels are in the region of 10dB above the ambient noise levels of the locations concerned.

20. Delegates are therefore of the opinion that an authority which has a ground running noise problem should take samples of the ambient sound level and the sound level which causes complaints. It should then initiate measures which will reduce the ground running noise to a level at which complaints disappear.

List of Papers Presented at the Conference

Except where otherwise indicated, papers reflect the views of their authors only and should not be regarded as official statements of government policy. Attention is drawn in this connection to the remarks by the head of the US delegation at the opening plenary session (see Appendix B, page 42). The German authorities have also pointed out that their papers are based on the personal opinions of the authors and do not necessarily reflect their Government's views.

Note: This list excludes papers which are not available for general release, and summaries of conference papers.

COMMITTEE NO. 1: THE DEVELOPMENT AND PRODUCTION OF QUIETER AIRCRAFT AND ENGINES

Number	Title	Country/ Organisation	Author
INC/C1/P6	The evolution of the engine noise problem	UK	F. B. Greatrex and R. Bridge (Rolls Royce)
INC/C1/P7	The United Kingdom aircraft engine noise research programme	UK	I. M. Davidson (National Gas Turbine Establishment)
INC/C1/P8	The effect of aircraft characteristics on the noise around airports	UK	J. F. Holford (Royal Aircraft Establishment)
INC/C1/P9	Noise reduction from the short-haul operators' point of view	UK	K. G. Wilkinson (BEA)
INC/C1/P10	Historical review of aircraft noise suppression	UK	Prof. E. J. Richards (Southampton University)
INC/C1/P11	A realistic look at the problems in design and introduction of new aircraft	USA	F. W. Kolk (American Airlines Inc.)
INC/C1/P12	Prospects for lower noise levels for current and future aircraft	USA	A. L. McPike (Douglas Aircraft Co. Inc.)
INC/C1/P13	Federal Aviation Agency noise suppression research and development programme	USA	J. F. Woodall (Federal Aviation Agency)
INC/C1/P14	Research approaches to alleviation of airport community noise	USA	H. H. Hubbard, D. J. Maglieri and W. Latham Copeland (NASA Langley Research Center)
INC/C1/P15	High bypass ratio engine noise	USA	T. G. Sofrin and J. C. McCann (United Aircraft Corpn.)

Number	Title	Country/ Organisation	Author
INC/C1/P16	Some aspects of the development of quieter aircraft	USA	J. B. Large and R. A. Mangiarotty (The Boeing Co.)
INC/C1/P17	Recherches de la SNECMA sur la reduction du bruit des jets	France	G. Richter (SNECMA)
INC/C1/P18	Sur le calcul du spectre de pression sonore maximale émis par les jets stationnaires et en vol	France	M. Kobrynski (ONERA)
INC/C1/P19	Organisation Générale de la Recherche sur le Bruit des Réacteurs en France	France	
INC/C1/P20	Amélioration des niveaux de bruit 'Caravelle'	France	J. Wagner (Sud-Aviation)
INC/C1/P22	The reduction of noise from turbo-jet aircraft	USSR	A. G. Munin
INC/C1/P23	Calculation of take-off noise characteristics of jet transport aircraft	USSR	V. E. Vlasov, V. E. Kvitka, B. N. Mel'nikov, A. G. Munin and L. I. Sorkin

COMMITTEE NO. 2: CONTROL OF NOISE BY THE SITING OF
AERODROMES, PLANNING THEIR LAYOUT AND LIMITING
RESIDENTIAL DEVELOPMENT NEARBY

Number	Title	Country/ Organisation	Author
INC/C2/P2	Control of noise by the siting of aerodromes, planning their layout and limiting residential development nearby	UK	
INC/C2/P3	The airport and comprehensive planning for metropolitan development	USA	J. B. Howes (US Dept. of Housing and Urban Development)
INC/C2/P4	Some problems of cost allocation to alleviate aircraft noise	USA	R. W. Pulling and R. F. Bacon (Federal Aviation Agency)
INC/C2/P5	Operations research programme to develop low noise air transport system at minimum cost	USA	J. M. Tyler (Society of Automotive Engineers)
INC/C2/P6	Legal and related aspects of airport land use planning	USA	L. M. Tondel, Jr. (Air Transport Association of America)
INC/C2/P8	Control of aircraft noise by airport siting and layout planning	USA	W. E. Downes, Jr. (Commissioner of Aviation, City of Chicago)

**COMMITTEE NO. 3: OPERATIONAL NOISE ABATEMENT PROCEDURES
DESIGNED TO LIMIT THE AMOUNT OF DISTURBANCE CAUSED BY
AIRCRAFT TAKING OFF, IN FLIGHT, OR LANDING**

Number	Title	Country/ Organisation	Author
INC/C3/P2	Operational noise abatement procedures designed to limit the amount of disturbance caused by aircraft taking off, in flight, or landing	UK	
INC/C3/P3	Take-off and landing techniques to accommodate noise abatement	USA	Air Transport Association of America
INC/C3/P6	NASA research on steepened approaches for noise alleviation	USA	P. Doneily, J. A. Zalovcik and W. T. Schaefer, Jr. (NASA Langley Research Center)
INC/C3/P7	Les procédures opérationnelles de réduction de bruit; applications et conséquences pour les exploitants aériens et les services au sol	France	
INC/C3/P8	Operational noise abatement procedures designed to limit the amount of disturbance caused by aircraft taking off, in flight, or landing	USA	Capt. H. F. L. Clark and H. F. Marthinsen (Airline Pilots' Association)
INC/C3/P9	An airport view of noise abatement procedures	USA	J. R. Wiley (Port of New York Authority)
INC/C3/P10	Operational noise abatement procedures designed to limit the amount of disturbance caused by aircraft taking off, in flight, or landing	West Germany	
INC/C3/P11	Operational noise abatement procedures designed to limit the amount of disturbance caused by aircraft taking off, in flight, or landing	Japan	
INC/C3/P16	Reduction and assessment of noise from civil aircraft	USSR	V. E. Kvitka and B. N. Mel'nikov

COMMITTEE NO. 4: METHOD OF SPECIFYING MAXIMUM
PERMISSIBLE NOISE LEVELS,
HOW SUCH LEVELS SHOULD BE DETERMINED, AND METHODS OF
ASSESSING COMPLIANCE

Number	Title	Country/ Organisation	Author
INC/C4/P2	Method of specifying maximum permissible noise levels, how such levels should be determined, and methods of assessing compliance—current practice in the UK	UK	
INC/C4/P3	Method of specifying maximum permissible noise levels, how such levels should be determined, and methods of assessing compliance—the subjective basis for aircraft noise limitation	UK	Dr. D. W. Robinson (National Physical Laboratory)
INC/C4/P5	General principles and operational parameters governing noise abatement procedures <i>(This paper relates also to Committee No. 3)</i>	IATA	
INC/C4/P6	Monitoring aircraft noise around an airport	Austria	Prof. Dr. F. Bruckmayer and Kustos Dipl. Ing. J. Lang (Vienna, Austria)
INC/C4/P7	Development and enforcement of noise standards	USA	A. H. Odell (Port of New York Authority)
INC/C4/P8	Community reactions to aircraft noise	USA	P. N. Borsky (Columbia University)
INC/C4/P9	Individual and community reaction to aircraft noise; present status and standardization efforts	USA	W. J. Galloway and H. E. Von Gierke (American Standards Association)
INC/C4/P10	Weather aspects of airport noise and its application to zoning and aircraft operating procedures	USA	A. Hilsenrød (Federal Aviation Agency)
INC/C4/P11	The legal sound of aircraft noise	USA	R. L. Randall (Federal Aviation Agency)
INC/C4/P12	Connaissance des bruits émis par les avions et spécifications envisagées pour l'agrément des avions nouveaux	France	
INC/C4/P13	Aircraft noise monitoring systems in use in Norway	Norway	B. Aakre (Directorate of Civil Aviation)

Number	Title	Country/ Organisation	Author
INC/C4/P14	Method of specifying maximum permissible noise levels, how such levels should be determined and methods of assessing compliance	West Germany	
INC/C4/P15	Regulation by law of aircraft noise levels from the viewpoint of United States airlines	USA	J. E. Stephen (Air Transport Association of America)
INC/C4/P16	Controle des bruits émis par les avions	France	
INC/C4/P17	Annex to INC/C4/P16	France	
INC/C4/P18	Proposal to establish noise levels specifications for commercial aircraft	Sweden	
INC/C4/P19	A system for aircraft noise rating	Netherlands	G. J. van Os
INC/C4/P20	Study of the influence of narrow band noises and tones on the subjective response to 'shaped' white noise	UK	T. J. Hargest and R. A. Pinker (National Gas Turbine Establishment)
INC/C4/P22	Legal and practical limitations on noise control methods	USA	Sidney Goldstein (Port of New York Authority)

COMMITTEE NO. 5: METHODS OF INSULATING BUILDINGS
NEAR AIRPORTS AGAINST AIRCRAFT NOISE

Number	Title	Country/ Organisation	Author
INC/C5/P2	The sound insulation of buildings near airports	UK	
INC/C5/P4	Standard methods for sound insulation and its measurement	USA	Dr. R. K. Cook (Dept. of Commerce)
INC/C5/P5	Methods of insulating buildings near airports against aircraft noise	Japan	

COMMITTEE NO. 6: METHODS OF REDUCING NOISE FROM AIRCRAFT AND ENGINES WHEN OPERATED FOR MAINTENANCE OR TESTING ON THE GROUND

Number	Title	Country/ Organisation	Author
INC/C6/P2	Methods of reducing noise from aircraft and engines when operated for maintenance or testing on the ground	UK	
INC/C6/P4	Methods of reducing noise from aircraft and engines when operated for maintenance or testing on the ground	USA	F. T. Fox (Los Angeles Dept. of Airports; American Association of Airport Executives and Airport Operations Council International)
INC/C6/P5	Méthodes de réduction du bruit causé par les avions et les moteurs lors des opérations de maintenance ou d'essais au sol	France	
INC/C6/P6	Reduction of noise resulting from jet aircraft maintenance requirements	USA	A. M. Ririe and M. W. Taylor (PANAM)
INC/C6/P7	US Air Force experience in reducing noise in ground runup operations	USA	G. B. Newton (US Air Force)
INC/C6/P8	Implications of measures to reduce ground running jet-engine noise at civil airports	UK	(BOAC)
INC/C6/P9	Committee title (at BEA base Heathrow)	UK	R. H. Doggett (BEA)
INC/C6/P12	Jet noise reduction	USSR	A. G. Munin, E. V. Vlasov and Z. N. Naumenko

GENERAL PAPERS

INC/GP1	General paper on problems of aircraft noise	Argentina
INC/GP2	General paper on problems of noise in the airport community (This paper relates largely to Committee No. 2, and to some extent to Committee No. 3)	IATA
INC/GP3	General paper on the ICAO Air Navigation Commission's programme for dealing with technical aspects of the problem of noise in the vicinity of aerodromes and its relationship with other international bodies concerned with this subject	ICAO Secretariat





BOARD OF TRADE

Aircraft noise

Report of an international conference on
the reduction of noise and disturbance
caused by civil aircraft

Lancaster House, London
22-30 November 1966



LONDON
HER MAJESTY'S STATIONERY OFFICE
1967

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Conference Chairman and Heads of Delegations

Conference Chairman	Mr. Roy Mason, MP Minister of State Board of Trade United Kingdom
Heads of Delegations	
Australia	Mr. J. H. Harper First Assistant Director General (Operations) Department of Civil Aviation
Austria	Dr. Rudolf J. Fischer Director-General Department of Civil Aviation
Belgium	M. R. Lecomte Director-General Régie des Voies Aériennes
Brazil	Major J. R. Mil Homens Costa Air Ministry of Brazil
Canada	Mr. J. R. Baxter Representative in London of the Department of Transport
Czechoslovakia	Mr. Karel Kouba Chief of The Airport Construction Division Civil Aviation Administration
Denmark	Professor Fritz Ingerslev Doctor of Technical Science and Professor of Acoustics Copenhagen Technical University
Finland	Mr. H. Seppälä FINNAIR
France <i>shared between</i>	M. Jacques Boitreaud Secrétaire Général à l'Aviation Civile <i>and</i> M. Pierre Joubert Ingénieur Général des Ponts et Chaussées
Federal Republic of Germany <i>shared between</i>	Dr. F. U. Schmidt-Ott Deputy Director-General of Civil Aviation <i>and</i> Dr. G. Lepke Regierungsdirektor Federal Ministry of Transport
Greece	M. Nicholas Papaioanou Director Airport Division Ministry of Communications
Ireland	Mr. Thomas L. Hogan Chief Airport Engineer

Italy	Sgr. Stefano Mossa Inspector-General Ministry of Transport and Civil Aviation
Japan	Mr. Hisayoshi Teraï Chief of International Affairs Section Civil Aviation Bureau Ministry of Transport
Lebanon	M. Zouhair Beydoun Director of Civil Aviation
Netherlands	Mr. C. A. F. Falkenhagen Chief of Aeronautical Inspection Division Department of Civil Aviation
Norway	Mr. Erik Willoch Director-General of Civil Aviation
Portugal	Sr. J. J. Augusto Chief of Technical Services Lisbon Airport
Republic of South Africa	Dr. C. G. Van Niekerk Head of Aeronautics National Mechanical Engineering Research Institute Pretoria
Spain	Lt.-Col. G. M. Olmedo Spanish Air Attaché in London
Sweden	Mr. Eskil Hellner Secretary General Ministry of Communications
Switzerland	M. Albert Münch Vice-Director Federal Air Office
Thailand	Dr. Boonsorn Boonsukha Chief of Construction and Maintenance Division Department of Aviation Ministry of Communications
Union of Soviet Socialist Republics	Mr. A. G. Munin Deputy Head of Section Ministry of Aircraft Industry
United Kingdom	Mr. Frank Wood Board of Trade
United States of America	Mr. Raymond A. Shepanek Director Noise Abatement Staff Federal Aviation Agency

Council of Europe	Mr. H. Pfeffermann Head of Public Health Division Secretariat General Strasbourg France
European Civil Aviation Conference	Mr. R. Burns Vice-President
International Civil Aviation Organization	Mr. J. A. Newton Chief, Flight Branch ICAO Secretariat Montreal Canada
	Mr. W. Binaghi President of the Council of ICAO <i>attended, and spoke at, the closing plenary session</i>
International Air Transport Association	Captain J. E. Frankum Vice-President, Transportation Trans World Airlines Inc. New York
International Civil Airports Association	Mr. G. W. Pitt British Airports Authority <i>(Also on the United Kingdom delegation)</i>
International Federation of Air Line Pilots' Associations	Captain F. Bateman KLM Pilots' Association
International Organization for Standardization	Mr. A. D. Falk Technical Officer British Standards Institution
Institute of Transport Aviation	M. R. J. L. Balat Chief Engineer
Organisation for Economic Co- operation and Development	Professor P. Atteslander Berne University
Western European Airports Association	Dr. W. Treibel Director ADV Stuttgart
International Association Against Noise	Professor Friedrich Bruckmayer University of Graz <i>(Also on the Austrian delegation)</i>

Conference Committees

Chairman

Committee No. 1

The development and production of quieter aircraft and engines

Mr. Harvey H. Hubbard
United States of America

Committee No. 2

Control of noise by the siting of aerodromes, planning their layout and limiting residential development nearby

Mr. Erik Willoch
Norway

Committee No. 3

Operational noise abatement procedures designed to limit the amount of disturbance caused by aircraft taking off, in flight, or landing

Mr. C. A. F. Falkenhagen
Netherlands

Committee No. 4

Methods of specifying maximum permissible noise levels, how such levels should be determined, and methods of assessing compliance

M. Pierre Joubert
France

Committee No. 5

Methods of insulating buildings near airports against aircraft noise

Mr. K. Alsop
United Kingdom

Committee No. 6

Methods of reducing noise from aircraft and engines when operated for maintenance or testing on the ground

Mr. G. F. K. Donaldson
United Kingdom

Secretary-General

Mr. W. J. Coe
United Kingdom